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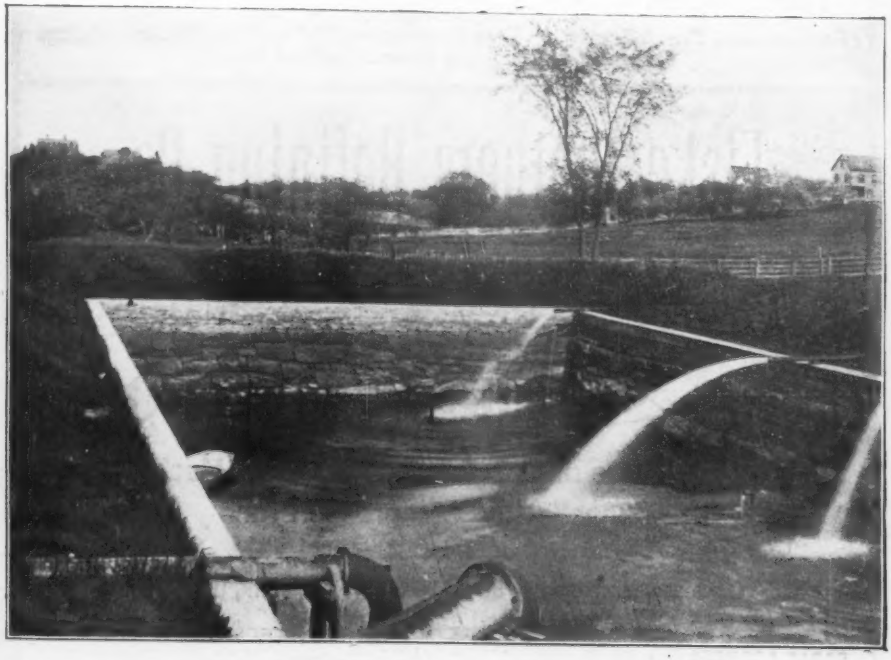

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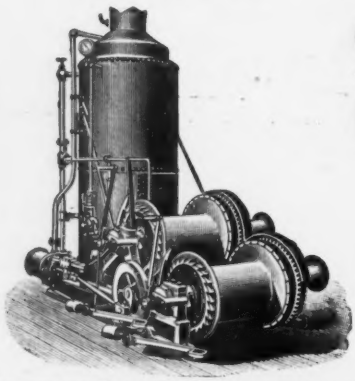

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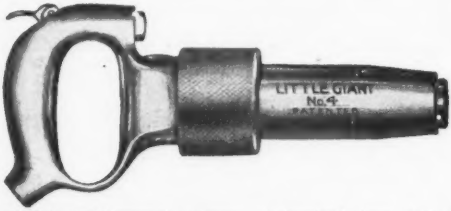

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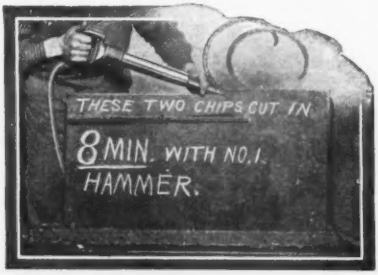

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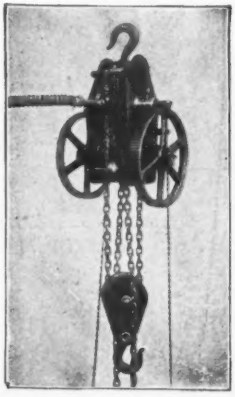

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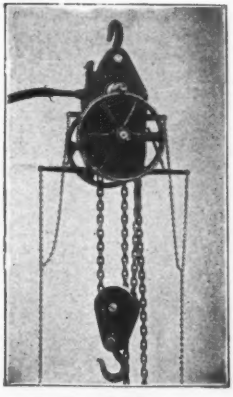

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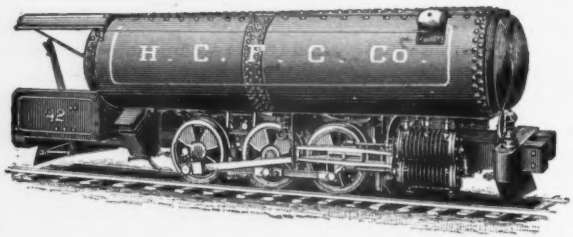

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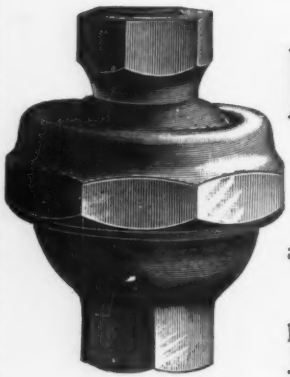

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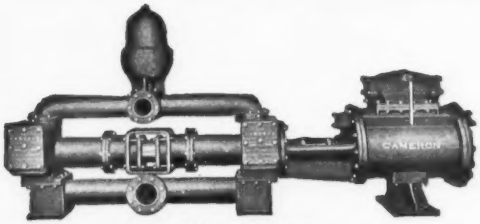

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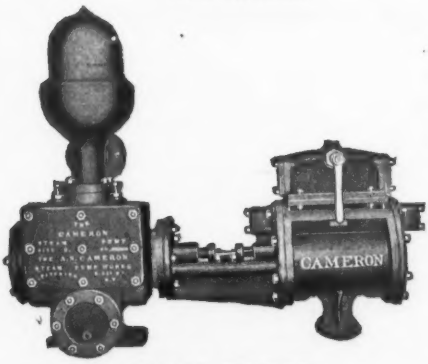

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VOL. VI. DECEMBER, 1901. NO. 10.

Elsewhere is this issue we reprint in full a paper discussing the subject of Pick Types of coal mining machine. This gives a historical review of the development of this form of labor-saving machine, together with the discussion of the paper which followed its presentation.

At first glance it may seem that in doing this, we have overstepped the boundary of compressed air and are in the field of mining. If so, our excuse is that mining, whether for coal or metals, involves the use of compressed air. It is further unquestionably true that the largest number of air compressors are at present operating in conjunction with mines of one sort or another.

To many it will be surprising to learn that since 1891 the total tonnage of bituminous coal mining in the United States by machinery has increased from about 6½ per cent. of the total output to over 23 per cent. in 1899. In this are employed over 3,000 mining machines, of which 2,000 are air pick cutters and nearly 200 air chain cutters. In addition to this, it is generally known that air is largely used for the operation of hoisting engines, pumps, rock drills, and other devices in and about the coal mines. In view of these facts, there is little need of dwelling more on the claims of the coal cutting machine to the attention of our readers.

The paper to which reference is made was prepared by L. J. Daft, who is perhaps as well versed as any one in this country on the subject of coal mining machinery. We believe that this paper is the first which has been published in which sectional views of the various machines now on the market are given, and an opportunity thus afforded for the reader to intelligently compare the principles of the machines.

One point is mentioned deserving of special mention as it sounds the key note of the reasons in the success of these machines. We refer to the adoption of the independent air actuated valve in preference to the forms which are rigidly connected to the moving piston. In view of the many failures in past experience with coal cutting machines, it seems somewhat odd that advantage was not at once taken of the principle which had been developed by years of experience with the rock drill. For after all, as has been stated, the coal cutting machine is nothing more than a special form of rock drill mounted on wheels in a horizontal position, and while the material in which this horizontal or under-cutting drill works, is considerably different from rock, still many of the principles governing the operation of the two machines are identical.

The earlier forms of rock drills all employed positively moved valves, that is, valves directly connected in one way or another to the reciprocating piston. Very little practical experience was necessary to prove that this type had limitations and the defects which came to light in the operation of these earliest machines rapidly developed the later form of drill in which the piston and valve were independent. If coal were an absolutely regular material, homogeneous and of a definite hardness and it were possible to hold the machine in such a position that the blows were always at a definite angle and of a determined length, it would be possible to employ a positively moved valve. This is very nicely brought out in the case of rock drilling, where experience has shown that the type of drills employing positively moved valves is satisfactory where the rock is even in character and not intersected by fissures and faults. The tripod maintains the drill at a fixed distance from the point where the cutting is occurring, and the drill is clamped so that the blow always occurs in one place. With the coal machine these conditions are entirely absent and the machine is free to move in any direction. As a result, when the pick drives into the coal or becomes fixed, the cylinder will of necessity shoot backward with practically the same force with which the piston is advancing, unless the air pressure in the cylinder is instantly cut off. Neglect of this point was the cause of the failure in a greater or less degree of all the earlier types of pick coal machines.

How this difficulty has been surmounted is well brought out by Mr. Daft's article, which should be carefully read by all who are in any way interested in any use of compressed air machinery in coal mining.

On the frontispiece of this issue is shown a simple and practical application of the air lift system as applied to water works.

The air lift discharges are seen at the right, while the two large pipes in the foreground connect with the pumps used to force the water through the service system.

It will be noticed that there are four separate air lift discharges shown in the picture. One of these is in full running order and the others are just starting up. This suggests one of the most valuable features of the Air Lift System, the facility with which a number of wells scattered over a wide area may be operated. The air for working these is conveyed in small pipes to the wells, which may be of such character as would make it impossible to operate them by any other means, such as steam pumps, deep well pumps, syphons or displacement pumps and the water raised and forced to a central reservoir. The compressor is the only operating part, and may be in the engine room convenient to coal and water. Air is the only medium carried to the well.

This system is rapidly coming into use wherever subterranean water supplies are available.

The Historical Development of the Pick Type of Mining Machine.*

BY L. J. DAFT.

The story of labor-saving inventions presents the most brilliant page in the annals of this century, which for mechanical achievement stands forth preeminent in history. We are yet too near the 19th century to realize the stupendous changes which have swept over the world; the field is so vast, and the changes so great, that only those who have given the subject special thought can have the faintest conception of the revolution effected in human life by the inventions and their developments in the past one hundred years. Life has been made easier, happier and better; civilization has been lifted to a higher moral and intellectual plane; our physical environment has been infinitely improved; nations have been linked more firmly in fraternal bonds through the

*From Proceedings of Engineers' Society of Western Pennsylvania.

agency of the telegraph, printing press, steamship and locomotive, and notwithstanding the wars which have but recently darkened the world's horizon, we are nearing the "Golden Age" of universal peace, which will register the last and grandest triumph of the mechanical arts over the turbulent passions of hostile nations, by the inauguration of brotherly rivalry in all that leads to the betterment of humanity and adds to the sum of earth's happiness.

At the very base and foundation of this marvelous development is coal, the leading source of energy, with which nature has blessed us so abundantly, and the production of which has become the most gigantic industry of modern times.

The observant traveler, on approaching this great manufacturing city, Pittsburgh, for the first time, is amazed at its murky skies and at the vast volumes of smoke pouring from thousands of stacks. On inquiry he finds that he is in the largest coal field manufacturing center in the world, with its countless factories, its vast emporiums, its palaces of art, its palatial residences and myriads of happy homes filled with a prosperous people. He realizes that but for our coal Pittsburg would be but an insignificant village nestling on the banks of the lordly Ohio, instead of this great imperial Iron City, and that if deprived of coal, the great pulses of industry would cease to throb; the hum of a million wheels would be succeeded by an appalling silence; her boats would mould and rot at the wharves; her halls of industries would crumble to dust; her palaces become the abode of desolation; her homes a dwelling place for the beasts of the fields, and written on her gates the legend "Thy glory is departed." Truly the value of this mineral, and the importance of its production, cannot be over-rated, and anything tending to render this prosperity greater is worthy of our attention. It, therefore, seems proper that at this time we spend a few minutes in discussing the origin and construction of some mechanical devices which are now playing an important part in coal production, and which are destined to fill a still larger field of usefulness in proportion as their economic value is more widely recognized.

It has often been noted that mechanical development runs in cycles, or periods of evolution; improvements are made, followed by a season of manufacture and sale, and for a time no further change suggests itself. Another period of unrest and alterations results in a further step forward, in line with advances in materials, new economic discoveries or changed methods of production. The last few years of the 19th century have seen this spirit of change and endeavor manifest itself with special force in the coal mining machine, resulting in remarkable advances.

I wish to say, before I proceed further, that, while I am identified with those engaged in this particular branch of manufacture, I will endeavor to record in this paper with absolute impartiality some of the many changes and improvements made by our predecessors and contemporaries, giving honor where honor is due, and freely acknowledging the large debt of gratitude which we all owe to those brave pioneers, who, ignoring seemingly unsurmountable obstacles, still struggled on, each bequeathing some improvement, until the ideas and conceptions of the original workers have crystalized in the symmetrical and effective percussive coal mining machine, commonly known as the "Pick Machine," "Iron Man," or "Puncher," as it is affectionately termed.

No machine which has played a notable part in any industry has been wholly the product of one brain and hand; each has been the child of evolution, a thing of slow growth; to this rule the pick machine has been no exception, and even in the last twelve months important improvements have been made which are destined to have a far-reaching influence, and which have placed this type of machine more prominently than ever before the mining public.

In this brief historical review, no attempt has been made to mention all of those who have contributed towards the splendidly successful machine of to-day, but we here gratefully acknowledge our indebtedness to those men and engineers who have labored in obscurity and discouragement to give form and life to an idea which is to benefit generations yet unborn.

In 1761 Michael Menzies of New-Castle-On-Tyne, England, patented a mining machine which has the distinction of being the first on record, and which embodied ideas whose development in later years achieved a large degree of success. Dur-

ing the next hundred years successive inventors appear, each marking a step forward, then passing out of sight, leaving the way more clear for others; gradually, as the result of their devoted labors, the successful machine emerges from among the multitude of forms and types.

In the year 1867 a patent was granted to Mr. Howit, of England, for a percussive machine which had some of the essential elements of the present pick machine. This machine was actuated by compressed air, operated upon an inclined sliding plane, and was mounted upon a universal joint, so that it had a lateral as well as a vertical swing; it required two men to operate it, and made its undercut in a manner similar to that of the modern pick machine. There being no device to check the recoil, the work was very laborious; the construction would admit of only a very narrow undercut at each setting of the machine. It was not a success, because of its mechanical imperfection, but Mr. Howit certainly deserves credit for blazing the way for others. It is along the lines marked out by him that engineers and manufacturers have since worked with success, partial or complete, attending different construction.

Butler built a reciprocating machine which was patented later as a rock drill. This machine was built after the fashion of the Howit, in that it was a reciprocating machine. It was an improvement over the Howit, and had a better type of valve motion. Certain means were provided for the piston cushioning without damage to the cylinder heads.

Some time after this Mr. Jonathan Harrison, then of Pennsylvania, built and patented a machine of similar type and appearance, but possessing many valuable improvements in detail of construction. Mr. Harrison probably did more in his day than any other man towards perfecting a machine which had in it the element of success and commercial value. He afterward disposed of his patents to Geo. D. Whitcomb & Co., of Chicago, to whom belongs much credit for the present success of machine mining, through persistent efforts, together with good work well done, in overcoming defects in early constructions. They tested many suggested improvements, and did more than any one else in overcoming the prejudices of the labor organizations, finally bringing forward machines of the present standard of efficiency. The later machine, as manufactured by the Geo. D. Whitcomb Co., still bears Mr. Harrison's name.

I shall make no attempt to describe in detail the earliest machines not now in use, where changes followed each other in rapid succession, but beginning with the present type of the Harrison cutter, which was in fact the first commercially successful machine, I propose to give a brief description of this and other machines of its type which followed in after years, with successive modifications and improvements.

Of all the pick machines that have emerged from time to time and have flourished to a limited extent, there are left today in the market but three machines, viz., the Harrison, the Ingersoll, and the Sullivan, these makes coming on the market in the order named.

The Harrison machine for many years back has been very similar in general construction to its present form, resembling all pick machines in being mounted on two low wheels, a single double-pointed pick being carried in an extension of the piston, the piston being thrown back and forth in its cylinder by means of compressed air, with a striking speed of 150 to 200 blows per minute. The earlier machines, or in fact the machines as they were built by the Geo. D. Whitcomb Co. up to within the last year, perhaps, were equipped with a rotary engine which was located in the air chest, and parallel with the piston. This device rotated a spiral wheel, the outer edge of which worked in a small cup valve, which was seated into the top of the main valve, some 15 or 18 inches long. This was a very clever device, although it was considered to be complicated. It had a multiplicity of wearing parts, all of which had to be watched and kept in perfect working order, as any leakage of air around the end of the cam would cause a spasmodic and irregular action, and create a very awkward movement of the machine.

There are differences in various details of all pick machines, these differences looking towards increased capacity, economy in the consumption of air, greater durability of wearing parts, various conveniences in operation, etc., the principal distinguishing feature being the valve motion, which is the most vital part of the

machine; the means for admitting and exhausting the air being, in effect, the heart and life of the coal cutter, and like the human heart, valve motions are good, bad, or uncertain.

Not having a cut of the earlier Harrison machine as first described, Fig. 1 will represent the new Harrison of Dec., 1900, and shows the improved rotary engine, with its vertical shaft, crank and pitman rod for operating the slide valve. Also the slotted piston rod guide, the cylinder having an air cushion and check valve in the back head, with leather cushion, fillers, and steel plates in the front head, supported by a pocket of compressed air; the non-adjustable, or rigid trunnion. Means for regulating the speed

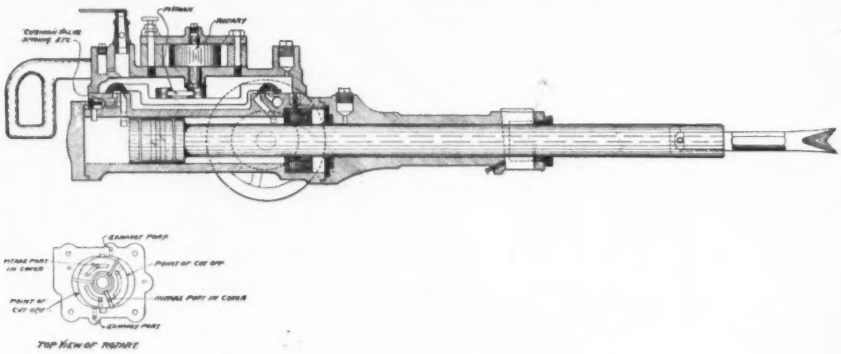


FIG. 1. THE HARRISON MINING MACHINE.

of this rotary engine are provided, and the rotary motion is accomplished by an arrangement of ports, which admit air into certain compartments while exhausting from other compartments. An important distinction will here be recognized in that this valve has no mechanical connection with the piston, as affecting or controlling its movements. If the piston were removed from the cylinder, the valve motion would be capable of performing its functions just the same, admitting and exhausting the air. This renders it a safe machine in the hands of learners. As above stated, the leather cushions, fillers and steel plates have been eliminated in the back head of the cylinder, and an air cushion substituted. This is a decided improvement, and there is no doubt but that the future will see this spirit of advancement demonstrated more fully, and that other improvements will follow which will make it a still more perfect and desirable machine.

The first machine of the Harrison type was sold in 1880, more than 20 years ago, and no doubt many of you can recall the strained relations between the miners and operators, the great opposition to machines and the obstacles thrown in the way of their successful use, the combativeness of the miners, the determination of the operators, and the resulting loss of life and property attending the introduction of machines into the mines. Nevertheless, machine mining trimuphed in the end, and the Harrison machine has had a long and successful career. In this connection we cannot say too much in praise of those who have so courageously and wisely fought these battles, and broken down prejudices and barriers at a time when assistance and recognition were so hard to obtain.

Fig. 2 represents an early pattern of the Sergeant coal-mining machine as it was built from 1889 to 1899, and shows the sliding or adjustable hub, or trunnion, the rubber buffer and steel plate in the back cylinder head, and the independent valve motion. As stated, this machine made its first appearance in 1889. The earlier machines were fitted with coiled steel spring buffers in the front end of the cylinder for the protection of the front cylinder head, and a rubber buffer was used to protect the back cylinder head. The steel spring gave way the second year of manu-

facture to an air pocket with leather cushion, filler and steel washer as shown, giving in effect the same cushion in the front end of the cylinder as that described for the Harrison machine. Various improvements were incorporated in many details. The adjustable hub or trunnions and adjustable handles were put on the machine in order to secure a perfect balance; better means for guiding the piston in its proper position were provided, preventing it from twisting; scraped joints were used instead of leather and rubber gaskets; the distinctive feature of the machine was its valve motion. This, like the Harrison, was independent of any connection with the piston, but differed from it in its greater simplicity and endurance; it consisted of two balanced plungers working side by side in the air chests, carrying

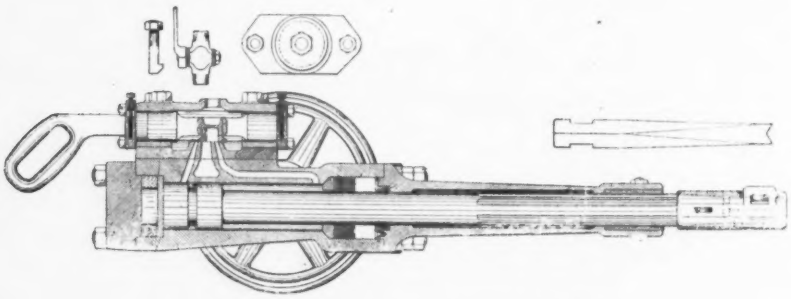


FIG. 2. THE SERGEANT MINING MACHINE.

plain "D" valves, one plunger acting as an auxiliary to control the main valve, the valve motion being complete in itself, admitting and exhausting the air at a speed determined by the regulating mechanism; this valve gear admitted of superior adjustment in the way of force, length and speed of blow, reducing reaction on the runner, etc. I consider this one of the most remarkable valve motions ever used in the history of mining machines. It is practically indestructible; the various ports are not clogged readily by coal dust; it operated well with air saturated with moisture; it was adjustable for any desirable effect, and in common with the Harrison, was safe for the machine runner. If the pick became fastened or stuck in the coal and prevented the piston from working freely and at its full stroke in the cylinder, this would not create any spasmodic or irregular conditions in the action of the valve; the valves, being independent, ran right along, admitting and exhausting the air; as the alternate transfer of the air pressure to each side of the fixed piston caused a free and easy to and fro motion of the cylinder, back and forth on the board, the pick was quickly set free without kick or danger to the runner. The point is that both the Harrison and Sergeant valves were free to reverse without full or violent travel of the machine when stuck. The distribution of air was such that this machine proved itself very efficient, and was in its day considered a very superior coal cutter. There was a great advantage in low cost of keeping up the valve mechanism, and after several years of experience with many different valve motions, this device made its record and proved to be the idea for a machine which must so often be used under cramped and adverse conditions.

The rock drill had been brought to a high state of perfection previous to this, the original coal cutters being a modification of the principles of the rock drill; in fact, the early coal mining machine was often referred to as "A rock drill on wheels." In drilling rock under a much greater variety of conditions than obtains in coal mining the question of valve motion was necessarily worked out thoroughly, and two general types alone have survived to this day viz., the independent valve motion, where there is no mechanical connection with the piston, the valves being controlled by a peculiarity of size and arrangement of ports, either independ-

ent of the location of the piston in the cylinder, or operating in harmony with it. The other type has been called the Tappet type in relation to the rock drill, but, considered mechanically, is a positive valve, always keeping in certain fixed positions in relation to the piston; being operated by a mechanical contact with the piston.

drills, and in the Yough and other obsolete coal machines, were reintroduced, doing entirely away with the minor parts of leather, steel plates, rubber buffers, etc., inside the cylinder, which were always a source of expense, annoyance and derangement when broken or worn. The workmanship and material were excellent,

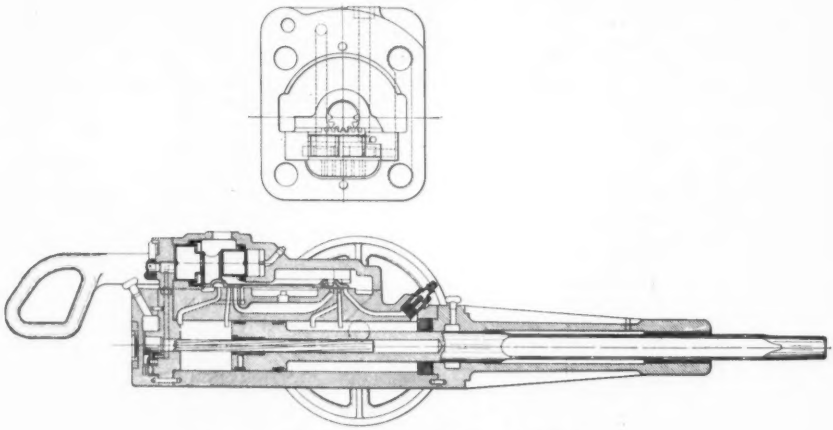


FIG. 3. THE SULLIVAN MINING MACHINE.

Fig. 3 represents the Sullivan coal mining machine. This machine has a differential valve plunger which is kept tight with cup leather packing, washers, bolts, etc., and moves by air pressure under control of an auxiliary valve, which in turn is dependent for its movement upon a rifle bar, shown in end section in the enlarged view of the back head. Air cushions protect both cylinder heads, and a device has been attached to this machine to vary the point of cut-off where it is considered advantageous. A babbitted bushing takes the wear in the front head, and prevents the piston from twisting. The trunnions, or hubs, are rigid or non-adjustable.

In 1896 this mining machine was placed on the market by the makers, who sold seven the first year, thus coming actively into the field three or four years ago. Radical departures were incorporated in this machine. The cylinder was made considerably larger than previous practice, giving greater power. Air cushions, such as were used in trip hammers, in rock and the machine was a leader for a time, and aroused considerable interest, comment, investigation and trial; the success and popularity this machine achieved were unqualified and complete.

The valve motion, of which we have already made mention, required that the piston be bored at the back end to a depth of some 22 inches, and fitted with a brass nut, which was rifled, to take this slender rifle bar. The reciprocating motion of the piston in the cylinder giving a backward and forward twist to the rifle bar, which, through a pinion and rack at its outer end, transmitted motion to the auxiliary valve which is placed on the back head, as shown. This auxiliary movement controls the movement of the main value plunger, which has connection with, and controls the main valve, which in turn admits and exhausts the air to throw the piston backward and forward—a triangular arrangement, each group of parts depending upon the others for its fixed movement and position. Various changes in detail were introduced,

the general outward appearance being, however, similar to its predecessors. Economy of air was sought and hoped for to an extent not entirely borne out by experience, because when the cut-off lever was adjusted for early cut-off and expansion in the interest of economy in air consumption, the blow delivered by it was ineffective in comparison, and therefore the device is not used in practice to the extent originally expected.

The introduction of the machines whose cushioning in both ends of the cylinder depended entirely on air pockets without the use of leather cushions, fillers, etc., brought with it a greater difficulty than was expected by the makers, and forced the use of a governing device by which the speed of the machine could be adjusted, regulated and held under control at all times and under all conditions. In the operation of the Iron Man it is necessary at frequent intervals to swing the machine away from the coal, in order to draw it back upon the working platform as the cut advances forward, and from left to right; and at such times it was discovered that without a governing device the machine would race, or run away, and become ungovernable in a measure, so that it was necessary to use a governing device to prevent this racing as much as possible. The device used for this purpose in this machine is very clever and ingenious, a small needle hole or port being drilled through the small main check valve, which is located at the front end of the cylinder, the port being drilled from the side of the valve, then straight up at the right angles through the valve stem, providing communication or connection between the cushioning pressure and the chamber above the main check valve. When the pick misses the coal, the piston cushions in the front end of the cylinder recompress the air that has been trapped in the pocket; the compression will be much higher than the line, or chest pressure. This high pressure—200 to 300 lbs.—is transmitted through this small port through the main check valve into the chamber above, and holds it fast upon its seat which prevents a fresh supply of live air from coming through this valve, and tends to retard the backward movement of the piston rod. This check valve is equipped with leather packing in order to prevent leakage, but apparently these leather packings become leaky in a comparatively short time, and there is more or less difficulty with the device with wear. There is also more or less danger of this small needle hole being stopped up with pipe line dirt, rendering the device inoperative. There is no doubt, however, that this machine is superior in many features to its predecessors; its capacity is higher, it is easily manipulated, it is accurately built of excellent material and promises to be economical in repairs; it is not wasteful in its consumption of air, and being pushed with the vigor and energy that characterize the makers, still further established the merits of machine mining, and that of the pick machine.

The success of this type of cutter naturally affected the business of the older companies, and the Ingersoll-Sergeant Co. determined at once to redesign their coal cutter, which had had a long and honorable career, but which was destined to undergo revolutionary and important changes. Peculiar advantages claimed for the mechanical valve drive corresponding to the Tappet feature in rock drills were urged by the original makers. It was known from 30 years experience in rock drilling that the independent valve motion was the best in percussive machines for all around work, yet it was recognized that the results secured from the rifle bar type of machine were good, though largely through the use of more powerful cylinders and air cushions, and that the rifle bar idea might be taken up, developed and improved to a point which would give good all around results in coal mining. That these expectations were not realized in the fullest sense has been proved finally and beyond contradiction.

Fig. 4 is a line drawing of the H. & H. —1 Ingersoll-Sergeant rifle bar coal-mining machine, there being no difference in the two except that the first mentioned undercuts from 4½ to 5 ft. deep, the latter being capable of undercutting from 6 to 6½ ft. deep. It has a single plunger valve with perfect air cushions in both ends of the cylinder and with other features common to the rifle bar type of machine, and having a cylinder of larger diameter than the previous practice. This machine was built in 1898 for the purpose of developing the rifle bar idea to its fullest possible extent. Its increased capacity by reason of the larger cylinder was apparent and un-

disputed. It was found that it was possible to so arrange the valve motion as to naturally cut off at the earliest part of the stroke consistent with the desired force of the blow, with the available air pressure, adapting itself without lever adjustment naturally to the changes in pressure from high to low. It was as economical in air consumption as any other, ran well on low or high pressure and promised to be as economical in repairs as could be realized with any machine of the rifle bar type. Notwithstanding the complications inseparable from this construction, it did excellent work, made many friends and partisans, and opened the way to new discovery and invention which was so soon to take an important place in the history of coal mining. It was at first without a governing device, so that an improved governor was designed, which I will describe in another part of this paper. The machine was capable of delivering from 200 to 240 blows per minute, and holds records of very fast work.

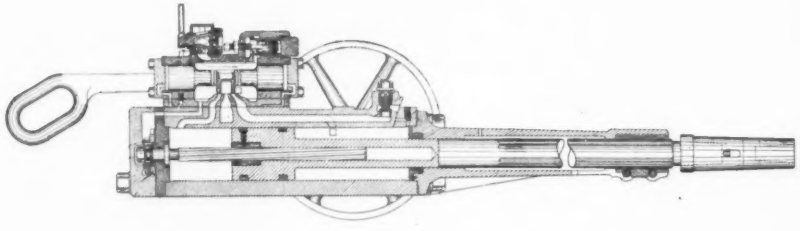


FIG. 4. INGERSOLL-SERGEANT H. & H.-I.

The Ingersoll-Sergeant Co. put out quite a number of these machines in different parts of the country, which gave them a very wide field for observation under varying conditions, and while these machines were put out in perfect good faith, and after tests by purchasers, proving that they were equal to any machine of a similar construction then built, yet further experience showed the fact that no rifle bar machine could ever be made as good an all around machine, and one that would be as permanently satisfactory to the mine owner and to the men who had to use them, as the independent valve construction. It was proved that it was not adapted to all kinds of coal, nor to wet air; that the repairs on the valve mechanism were high as compared with the independent valve, because there was a multiplicity of parts in the rifle bar type, all of which were subject to continued and destructive wear and breakage, which was a serious source of weakness, as this accumulated lost motion, resulting from wear, must inevitably disarrange the travel of the auxiliary valve, and affect the whole operations unfavorably. One of the objections to this type of valve gear which was offered by the men who had to use them, was that of the machine kicking backward on the running board on starting, or if the machine pick was driven so deeply into the coal as to cause it to hang on stick. This irregular, or spasmodic, action was due to the fact that the valve plunger could not reverse, because of its mechanical connection and relationship with the piston, until the latter had traveled its fixed distance in the cylinder, and the piston having thus been made temporarily rigid or stationary by the pick striking in the coal, the cylinder was thus made to effect the full travel on the running board, and the machine became the moving object instead of the piston. This made a very awkward movement, the full travel representing some 12 or 14 inches back and forth, and introducing an element of danger by this sudden change of action, in that the machine was liable to kick its full travel with great force, jerk the pick out of the coal, and possibly crush the runner up against a mine prop and seriously injure him. This feature was especially dangerous in thin seams, when the runner is cramped in the small

space left by the high board, and severe on the runner's hands if cutting close to a rib.

This company probably spent more money in the development and perfection of the rifle bar type of machine than any other, gradually reaching the ultimate perfection of that type; but, recognizing the weak points as described, they were induced to reopen the independent valve drive construction with larger cylinders and with air cushions, looking towards the final simplification and perfection of the pick machine, with results which I consider must be very gratifying to them as well as to the coal owner, and also to the men who have to handle these machines for a livelihood.

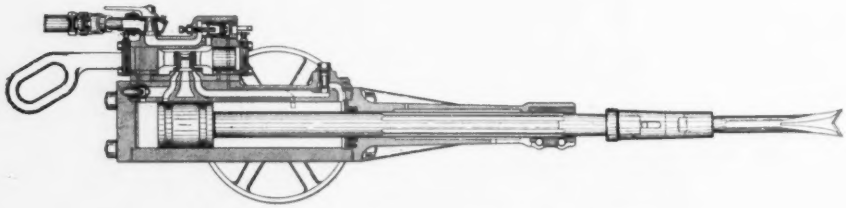


FIG. 5. THE NEW INGERSOLL F-4, H-4 AND H-5.

Fig. 5 represents the "New Ingersoll" mining machine F-4, H-4 and H-5 series, the difference between them being that the H-4 undercuts to a depth of 4 to 5 ft., and the H-5 undercuts from 6 to 6½ ft. deep. The F-4 is the same throughout as the H-4, but is a light pattern for thin seams, weighing but 550 lbs., and undercutting 5 ft. deep. The latest model of wheel is not here shown; it is now made slightly thicker in the rim and hub than the early patterns of wheel, and are spread further apart for the purpose of absorbing the recoil, jar and side glance. The trunnions are of the adjustable pattern for perfect balance, as described in another part of this paper. A new unbreakable bronze bushing, to take the wear in the front head, is shown; an automatic governing device is shown in top and front end of the valve chest. The independent valve motion is a modification of and an improvement over the arrangement which gave such valuable results in the earlier G-2 machine. The port arrangement is such that both cylinder heads are protected by air pockets, and this air pocket or cushion, while it is effective under all conditions, is secured with moderate compression of exhaust air, which reduces clearance loss and the strain on the machine and the man who runs it. The thumbscrew, regulating adjustment as formerly used, serves to regulate the speed of the valve movement, a detail cut of which is here reproduced in order to give a more comprehensive idea of its simplicity.

The valve seat or plate is shown separate from the valve chest; two plates have been photographed, so that the port arrangement on both sides may be seen. The "D" valves are a free sliding fit in the plungers, so that their wear may be followed up by the air pressure on top of them. They are tongued and grooved, and the plungers are doweled; the plates are drilled off center, so that they can only be put together right. The automatic throttle governor is an interesting feature belonging to this machine. It is a small balance plug valve located in the top and front end of the air chest, its front end having a port conection with the air cushion in the front end of the main cylinder. The throttle and governor are so located that the air passes through this governing valve on its way to the air chest. Should it become necessary to swing the pick away from the coal for any purpose, the piston of the machine when working up against the air cushion in the front end of the cylinder builds up a pressure somewhat higher than the line pressure, and this higher pressure is transmitted through this port to the front end of the governing valve, which shoots it over the supply port and against the line

pressure, cutting down the supply of air to a point where the machine will run lightly and at a reduced speed and force until such time as the pick is again thrown against the coal, at which time the valve automatically opens instantly and the machine is brought into instantaneous action with full pressure and force, without any annoyance or inconvenience, and introducing an element of safety and confidence for new men learning the work. Experienced men who swing the machine or the pick away from the coal less frequently, can throw this governor out of gear so that it becomes inoperative if they so desire. The valve is unbreakable and there is no "racing" with or without the governor, the speed being as regular and steady as a steam engine, whether being operated easily or full force.

The view of the "New Ingersoll" valve motion shows a most curiously simple arrangement. Both sides of the valve seat or plates are shown, also the two plungers side by side, with their loose "D" valve. These plungers are hollow, and hence light; they are perfectly balanced, and the wear on them is very slight. The earlier type of valve gear similar to this ran for years without repairs. One of these valves is simply the auxiliary valve, or trigger, to the other plunger, and it will be seen that their movements are controlled by permanent arrangement of ports, admitting and exhausting pressure alternately on both ends of the piston. This arrangement of ports and valves makes it an independent movement; and the piston could be blocked in the cylinder at part travel, with the result that the valves would run on continuously, admitting and exhausting in the same manner as if the piston were moving in harmony with it. No amount of wear in any other part of the machine can affect the valve movement, and no amount of wear in the valve mechanism can affect the action of any other part of the machine.

This last mentioned machine has perhaps been subject to more discussion on the part of coal mining operators and others than any other machine ever placed on the market. It is the simplest construction imaginable, the two plunger valves and the piston being practically all the moving parts, and these being free from strains or wear other than that naturally following very long use. The parts which experience shows to be subject to wear and breakage are simply discarded and left out altogether, and it was not until it had been put to the most severe tests in various mines throughout the country that people recognized this as being well past the experimental stage, and standing as a new creation, contain-

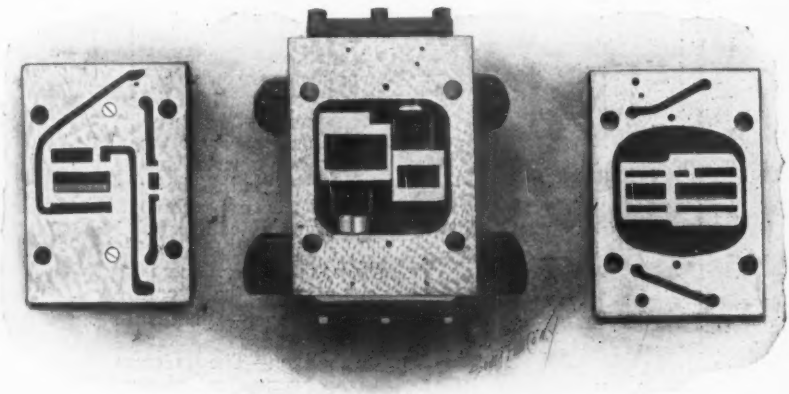


FIG. 6. VALVE MOTION OF THE F-4, H-4, AND H-5 NEW INGERSOLL.

ing improvements of the highest value. To insure the slowest possible wear and minimum breakage under the roughest usage, the qualities of the metals have been carried to the highest point of endurance —charcoal iron chests and cylinders of a toughness exceeding rigid government specifications;steel and malleable castings; tool steel pistons and other forgings toughened by a new oil treatment, raising their tensile strength to about 135,000 lbs. per square inch section, with an elongation before breakage under test nearly double that of metals not so treated. These have resulted in practically an entire absence of repairs for over 200 machines in the last year.

And so it is that competition drives us all from one improvement to another, each one bringing out something new from time to time, and bringing his machine to the highest standard of value—and making it a more profitable investment for the coal mining operator. It seems now that it is only a question of time when these machines will be applied in every district, and to every important and successful coal mining operation in the country.

DISCUSSION.

Mr. Fisher—I am sure you will agree with me that we have listened to a most interesting paper. The wording is beautiful in its style, and the descriptions of the machines are so clear that you can almost understand their construction without looking at the illustrations. I am sure it will open up a wide field for discussion. Perhaps Mr. Dixon can give us some further information.

Mr. Dixon—I cannot give more than is given here. I have the very essence of Mr. Daft's knowledge of these matters here.

Mr. Fisher—A paper of this kind is very valuable in the Proceedings of this Society. It seems to cover the whole field. I hope we will have more papers of this kind.

Mr. Ridinger—I would like to ask how long it would take to make a cut 3 feet wide and 5 feet deep.

Mr. Dixon—Of course, that depends on the hardness or softness of the coal, and it depends upon the man operating the machine a great deal. In making a cut with this machine, they usually make a cut about 5 feet wide and from 5 to 6 feet deep. Now, I had a man at the North Jericho mine, in Kentucky, about a month ago who cut 211 lineal feet, 4½ feet deep, in eight hours and twenty minutes. He cut one room 60 feet wide in one hour and thirty-five minutes. I remember well because I bet him a box of cigars, and he cut it in one hour and thirty-five minutes. That is hard coal. The same man at a mine in West Virginia cut 265 lineal feet, five feet deep, in nine hours. Of course, this was done by a man who was a thoroughly skilled cutter, and does not represent the average work. There are a great many men who can do that, however, but I should say the average work would be about half of that. If you would take coal of average hardness, 100 feet, 5 feet deep, would be a fair day's work. Of course, the tonnage in that would depend upon the height of your coal.

A Member—I would like to ask if this is applicable in other kinds of mining, in cutting quartz and hard slate?

Mr. Dixon—The machine can be used in cutting fire clay of medium hardness, but not for quartz, sand-stone or hard rock of any kind. The Ingersoll-Sergeant rock-drills have a record of 75 feet in ten hours, but, of course, when it comes to undermining rock of that kind, it is simply impossible. There has never been a machine made that would do it.

Mr. Ridinger—What is the height of the undercut?

Mr. Dixon—The undercut would represent an average cut of seven inches, if it was made uniform. It tapers back from the front. In undercutting the coal is not made all slack. A skilled cutter could make about one-half lump and one-half slack. None of it is made quite as fine slack as that from other types of machines.

A Member—In giving a mine a lineal cut of a 150 or 250 feet, is there a way to move the machine sideways in that direction, and then is the machine operated by one miner and followed up by others, who break down the coal with pick action?

Mr. Dixon—A good method in coal mining is to have the rooms 20 to 25 feet wide. In the case I speak of, all the rooms were 20 to 60 feet wide. The machine is placed on a board and there is a cut put in 5 feet wide and 5 or 6 feet deep and as soon as they have finished, the machine is moved across and that is blasted down. Where the room is 20 feet wide a shot in

each rib will break down the coal. That is nearly always done by the men who load the coal. The work is generally done by so much for undermining and so much per ton for shooting it down and loading it.

Mr. Ridinger—Would there be any way of figuring the horse-power required to make a cut?

Mr. Dixon—Yes, the machine will use from 60 to 75 cubic feet of air per minute.

A Member—How much air pressure do you carry?

Mr. Dixon—The usual pressure is about 80 pounds. The machines run very well with 65 or 70 pound pressure. With the Ingersoll-Sergeant machines it is not necessary to have more than 70 pounds.

A Member—How far can you carry the air?

Mr. Dixon—With proper piping, I know of places where they carry it 4 miles. In tunnel work there are cases on record where they carry it much farther.

A Member—Do they have large pipes?

Mr. Dixon—The larger your pipe is, the more economically you can carry the air.

A Member—Do you ever have any trouble with freezing?

Mr. Dixon—The air comes from the compressor into the reservoir which takes out a great deal of the moisture and inside of the mine is another reservoir and that takes out the moisture which is left behind. The air is comparatively dry when it goes into the machine. The warmer it is the more efficient it is. I visited the Cambria Mines at Johnstown and I found them running 13 machines with a three-inch pipe three miles away from the compressor. They had less trouble that far away from the compressor than they had close to it.

A Member—I understand that the walls of those rooms consist of pillars of coal?

Mr. Dixon—Yes, columns must be left in or the roof would come down.

A Member—What kind of a tool do you use?

Mr. Dixon—The pick is simply a shaft that works out and in on a piston and strikes the coal. Of course, the amount of work done depends upon the man behind the machine.

A Member—Is that shaft ground hard steel?

Mr. Dixon—Just ordinary iron like a miner's pick.

A Member—Does that machine make much dust in the mine?

Mr. Dixon—Of course, it makes some dust where it is perfectly dry, but it does not make nearly as much dust as any other type of machine.

A Member—You spoke of making a cut 5 feet wide.

Mr. Dixon—The end of the machine can be sprung in any direction. It moves freely and a man can move the machine any way he pleases. The end of the machine can be sprung backward and forward. A cut about 14 inches high in front tapers down. It is V shaped.

Mr. Fisher—When you go to cut out a room, how do you start your first cut?

Mr. Dixon—You would do that just the same as though you were mining on this wall here. Run the cut right along on the bottom and at the extremity of the cut on each side there is a hole drilled in and a cartridge of powder put in.

A Member—Has any attempt been made to apply electric power to the drill?

Mr. Dixon—Yes, but so far it has been unsuccessful. The difficulty is in applying the power.

Mr. Hirsch—Do you imagine that the difficulty is due to a mechanical defect in the design.

Mr. Dixon—Well, it may be. I am not sufficiently acquainted with it myself, but I know that the makers have been working a long time trying to make an electric drill. Of course, I do not really know enough about it to make any definite statement as to whether it ever will or will not be successful.

A Member—I have heard it said that the air exhausting into the mine purifies the atmosphere in the mine itself. Is that worth counting on?

Mr. Dixon—I don't think that is worth counting on. If a man fires a shot he can turn on the air and blow the smoke away. Of course, the air is perfectly pure and perfectly cool so that it helps in tight places considerably.

A Member—Has there ever been anything made in the way of a rotary cutter for use in mining?

Mr. Dixon—Yes, there is a rotary power machine. It was fairly successful while they used it, but it is obsolete now.

Mr. Ridinger—I had quite an experience last week. There are a number of capitalists interested in a new mining machine,

The mining machine is made with two flat discs on the head of a carriage that runs in and out and these discs rotate out from the center. On the circumference of the discs there are bits screwed in and also along the top and bottom there are bits. The average power required while making a cut 3 feet wide, 4.5 feet deep, and 9 inches high, was approximately 13 h. p., and the time 3 minutes.

A Member—What was the height of the undercut?

Mr. Ridinger—Seven inches. The carriage was three feet wide. Another thing, it does not appear to make such fine slack but it takes it off in little pieces, some of them as large as a walnut. Of course, they had to have a boy to shovel the coal away.

Mr. Dixon—What is the name of that machine?

Mr. Ridinger—It has no name. It was tried a number of years ago. It did not have any way to carry the coal cuttings away from the end of the cutters and they disbanded it and had it stored until some expert machinist got them to take it up again.

A Member—Mr. Dixon, can you say about what the temperature would be in those English mines?

Mr. Dixon—The men work in their shoes and breech clothes. It is very warm; I should say about 80 or 85. In order to get the air down to them they have to use all kinds of methods. That mine is very deep under ground and a part of it is under the German Ocean. Fans take the places of other methods of ventilation very largely.

Mr. Schleuderberg—Mr. Ridinger, with the machine you spoke of, did you strike any sulphur balls?

Mr. Ridinger—No. The owners say, however, that they have struck sulphur balls but it appeared to wade through them just as though it were soft coal.

Mr. Schleuderberg—The machine that will cut through sulphur balls is yet to be found.

DISCUSSION COMMUNICATED AFTER THE MEETING.

Mr. Ridinger—What is the average cost of power required to make a cut 3 feet wide and 5 feet deep, with the pick machine in average grade of coal?

Mr. Daft—The accompanying table is the result of one day's work with an Ingersoll machine in an 8 ft. seam, and where the coal was very tough. We see that one machine produced 855 square feet in eight hours and forty minutes, or an average of 1.644 sq. ft. per minute. On the basis of 10 machines undercutting 8,000 sq. ft. per shift in 8 ft. coal, we then have 8,000 divided into the daily operating expenses, which in this case would be $17.50 per day, or one-fiftieth of a cent per sq. ft.

OFFICIAL REPORT.

Star Junction, Pa., May 23, 1900.

Report of contest between Ingersoll Mining Machine, run by Fred. Woodward, and Sullivan Mining Machine, run by Al. Spray, resulting in a victory for the Ingersoll Mining Machine. Contest made by the Washington Coal & Coke Co., at their works at Star Junction, Pa.

Mr. Ridinger—What would the $17.50 include?

Mr. Daft—It would include all labor, such as engineer, firemen, pipe man, blacksmith work, fuel, oil and waste, interest (6 per cent.) and deterioration (10 per cent.).

Mr. Ridinger—What is the percentage of loss of power in transmission of air from the compressor to pick machine, pick machine being three miles away from the compressor, there being six machines working?

Mr. Daft—Six machines three miles from the compressor would require in the neighborhood of 480 cu. ft. free air per minute. If this amount of air is transmitted through a 4-in. line at 100 lbs. gauge pressure, the loss would be about 15 per cent.

Mr. Ridinger—How long a time does it take to change the position of the machine, and what is weight of same?

Mr. Daft—By referring to the table given, it will be seen that the time of moving can be put safely at one to three minutes when moving from one cut to the next, and from eight to thirteen minutes to move and set up in another room. The machine is built in 550 pound, 750 pound and 830 pound sizes.

Mr. Ridinger—Referring to the Star Junction case, was this a contest or was the machine working under normal conditions?

Mr. Daft—It was a contest between the Ingersoll and another make of pick machine.

Mr. Ridinger—How long a time does it take after placing the machine to make a cut 3 ft. wide and 5 ft. deep?

Mr. Daft—I have timed an Ingersoll-Sergeant machine in the Pan Handle Mine of the Pittsburg Coal Company many times where it under-cut 4½ ft. wide by 5 ft. deep in six and one-half to seven minutes. I have timed it in softer coals where it did the same work in five minutes.

Mr. Ridinger—Have there been tests made in that mine with other types of machines?

Mr. Daft—Yes, they used a chain machine there for a long time, but it could not be applied to the same advantage as the pick type, in fact, the prop question and the pillar drawing question debarred its use in the mines.

Mr. Ridinger—Do you have any trouble with the metal parts, in the valve and mechanism, crystallizing from constant jarring?

Mr. Daft—No. One of the peculiar features of this valve is that it seems to be everlasting. The valve plungers work against air cushions at both ends, hence there is no chance for crystallizations.

Mr. Daft—The valve, and in fact all other parts are put through a new process of oil treatment which renders them practically unbreakable.

F. Woodward cut, May 4, 1900, 9¾ rooms in 8 hours, 40 min., as follows:

Room No.	CONDITION OF ROOM.	Minutes cutting 1st board.	Time moving board.	Minutes cutting 2d board.	Time moving board.	Minutes cutting 3d board.	Moving to and setting in next room.	Depth of cut.	Width of room or lineal feet.	Square ft. in cut.	Total time cutting room.
56	Good Face and Bottom.			10	2	9	8	5.66	10.25	58	21
57	" " " "	16	2	14	2	10	10	5.25	16	84	44
58	Horseback,	16	3	16	3	13	11	5.5	16	88	51
60	Good Face and Bottom.	16	2	15	2	14	11	5.33	17	90.6	49
61	" " " "	15	1	13	1	11	9	5.5	17	93.5	41
62	" Supper, 30 Min.	14	1	13	2	12	8	5.33	16.5	87.9	42
63	" Face and Bottom.	18	2	14	2	12	13	5.33	16.5	87.9	48
65	" " " "	15	1	14	1	11	9	5.25	16.5	86.6	42
66	" " " "	11	2	13	2	12	10	5.33	17	90.6	40
67	" " " "	20	2	15	2	14		5.5	16	88	53
	Total time cutting room, 8 hours, 40 min.								158.75	855.1	

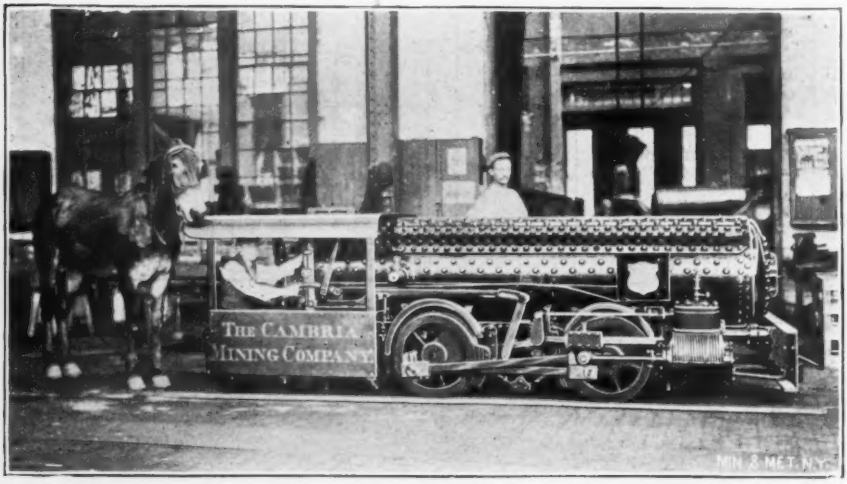
The move from room to room being about 500 feet.

The turnout of coal being about 340 tons per day. Air pressure, 80 lbs.

Compressed Air Mine Locomotives.

While in a vague, general way the underlying principles of the use of compressed air as a motive or haulage power are familiar to most of us, the details of actual practice and the successful operation of an air-haulage plant are matters not generally well understood. Recent practice in the operation of such a plant has gone to show that the cubic capacity and pressure of the locomotive, pipe line and compressor must be proportioned to secure the most satisfactory results. Enough energy must be contained in the locomotive to run the required distance, hauling its specified load, on a single charge of air. The pipe line or other form of storage-reservoir must have cubic capacity and pressure enough to

charge the locomotive instantaneously when coupled to it. When the locomotive after a trip comes back with its pressure reduced to say 50 or 100 pounds, and is coupled to the pipe line, the pressures in the two equalize to the required pressure for charging the locomotive. The compressor must be of such capacity that at convenient speed it will restore the pressure in the pipe line by the time the locomotive gets back for the next charge. By this method the compressor works at a practically uniform speed, without interruption, and the time required for charging the locomtive each time it comes back is only about one minute. The compressor is adjustable, so that in slack times the speed may be reduced, and also the pressure in the pipe line reduced, or in times of extra demand both speed and pressure may be increased.



A TYPICAL COMPRESSED AIR LOCOMOTIVE; BUILT BY THE H. K. PORTER COMPANY.

The illustration shows one of a pair of compressed air locomotives lately installed by the H. K. Porter Company, of Pittsburgh, Pa., for the Cambria Mining Company, of Cambria, Wyo. The leading dimensions of these locomotives are as follows: Gauge of track, 42 inches; diameter of cylinders, 7 inches; stroke, 12 inches; four driving wheels, 23 inches diameter; limit of height, 4 feet 2 inches; limit of width, 5 feet 10 inches; length, 12 feet 10 inches. These motors are of single-tank style, tank 33 inches diameter, of special quality of steel, 11-16th of an inch thick, for a working pressure of 800 pounds. Weight of locomotive, about 14,000 pounds. The outside surfaces of the cylinders are corrugated, for the purpose of exposing additional surface to the atmosphere. The main tankhead is made with a heavy steel manhole, so that the tank may be examined whenever desired; the riveting is done by a heavy compressed-air hydraulic riveter; the cylindrical part of the tank is a single sheet, with outside and inside welt strips. The compressed air, at a maximum pressure of 800 pounds, passes from the main tank through an automatic reducing and regulating valve patented by the manufacturer into an auxiliary reservoir, which is not seen in the illustration, and from thence it passes through a special balanced throttle to the locomotive cylinders, the distribution of air being governed by the usual link motion, just as in ordinary steam locomotives. The practical details of air distribution have been worked out in a most simple and efficient

manner, so that a uniform pressure of 140 pounds is maintained in the auxiliary reservoir, no matter what the pressure may be in the main tank, and no matter whether the engine is working hard or standing still. This obtains until the pressure in the main tank drops below 140 pounds, when the air passes into the auxiliary reservoir at the main tank pressure. All these details are worked out in compact and at the same time convenient shape, the small size of the motor being shown in the illustration by comparison with the mule.

These locomotives are guaranteed to haul seven loaded cars, each weighing, including the load, 4,200 pounds, up grades of four and one-half per cent., or five cars up grade of six per cent., and to handle their trains a distance of 5,000 feet up average grades of somewhat less than one per cent., returning with the empty cars, on one charge of air. The locomotives are used for hauling on cross-entries, delivering the coal from the mine workings to the main haulage-entry, which is a slope operated by rope-haulage. In actual practice the guarantee was considerably exceeded, one motor pulling six cars up grades averaging six per cent., starting on the grade, and with short lengths of nine per cent grade. The fact that in actual practice the motors have so largely exceeded their guaranty and their great efficiency and convenience in operation has resulted in the ordering of additional motors for other parts of the mine.

The Cambria Mining Company's air haulage plant is equipped with one three-stage compressor with a capacity of 600 cubic feet of air per minute at a pressure of 950 pounds, and with about two miles of pipe-line. This pipe-line serves as a storage-reservoir for air, and also affords opportunity for charging stations at different points throughout the workings.

The H. K. Porter Company has installed more than thirty air-haulage plants, each with from one to twelve locomotives, both for surface and for underground work, for gauges of track running from 18 inches up to standard gauge, and locomotives running from about 5 tons to 25 tons weight.

By paying careful attention to details and by improvements in construction the company has made a most unqualified success of air haulage. Such matters as theoretical expectation of trouble from refrigeration do not appear at all in actual practice. Such losses as are inevitable in converting steam-power into air-power compare favorably with any other form of transmitting power, not excepting electricity. The company's engineers state that compared with electric haulage, compressed-air haulage is far simpler, more reliable, and is not subject to breakdowns and interruptions; that it is absolutely safe in gaseous mines where electricity is as dangerous as steam; it is more flexible and convenient, inasmuch as the air locomotive is a complete machine in itself, able to reach all parts of the mine, wherever a track may be laid, and does not require any outside apparatus corresponding to a trolley-wire. As compared with either steam locomotives or electric locomotives, compressed air is cheaper to operate, the air tanks and connections being practically indestructible, and the wear confined almost wholly to the wheels and brasses and connections.—*Mining and Metallurgy.*

Air Jacks.

Sketches 1 and 2 show designs of an air jack for removing the drivers from a locomotive. The details are shown in Figs. 3, 4 and 5. These jacks were designed by Mr. G. L. Van Doren, foreman of Beardstown shops, Beardstown, Ill.

The sketches are plain and do not need any explanation. The air pressure used is 120 pounds per square inch. An advantage in using these jacks is that the work can be done very quickly and easily, and where an overhead crane is not used it would seem that they are almost indispensable. They are very much quicker than a hydraulic jack and easier to operate. On a standard engine it is no uncommon thing to remove the drivers and trucks and place the engine on blocks the proper height in from twenty to thirty minutes.

Figs. 6 and 7 are two other ingenious designs of air jacks used for passenger car work by the Wabash Railroad Company in St. Louis. Any one interested in this class of work will see that these jacks have several nice features. The sizes of the jacks can be varied to suit the work they are to perform.—R. T. SHEA, in *Railway and Locomotive Engineering.*

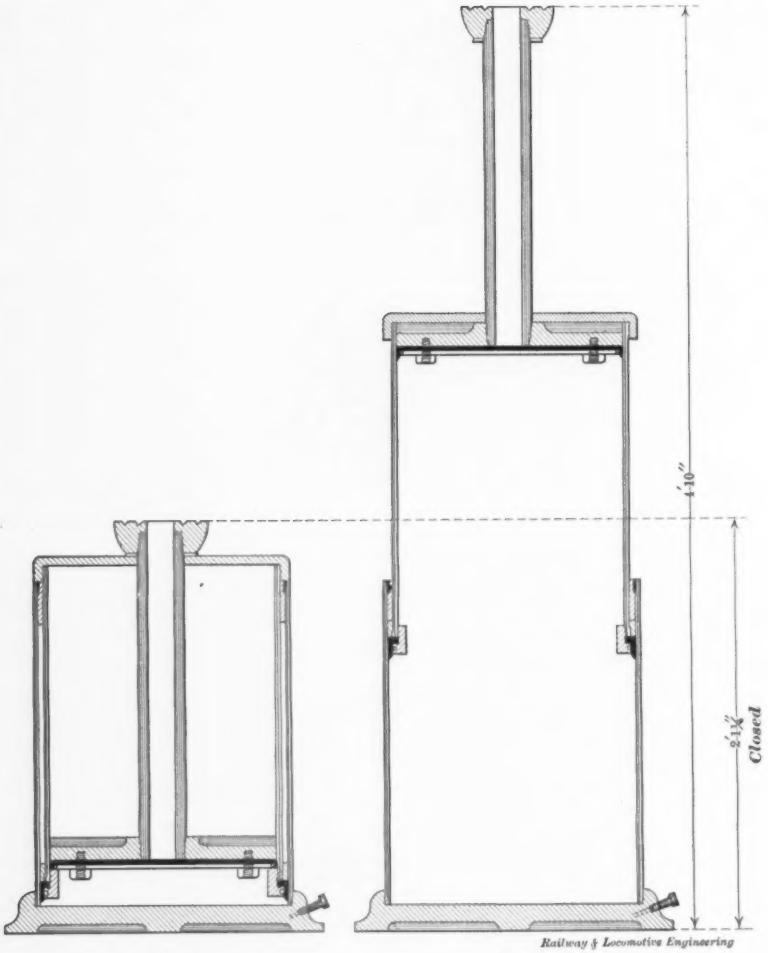


Fig.1 *Fig.2*

AIR JACK DETAILS.

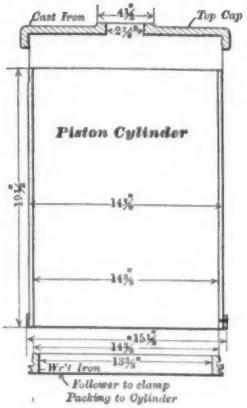


Fig. 3

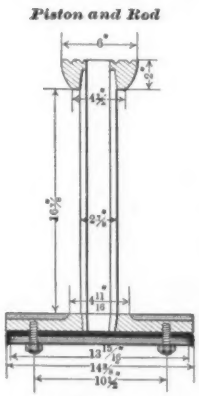
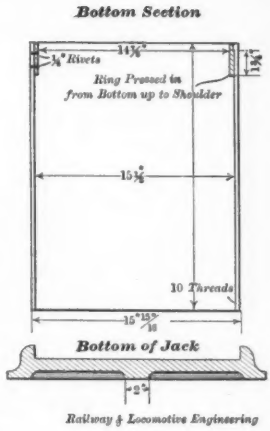


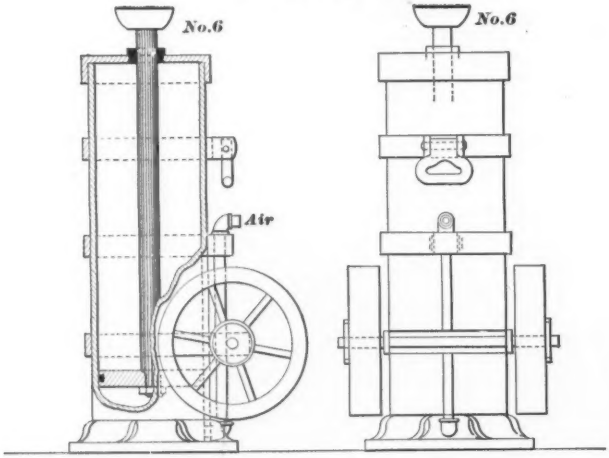
Fig. 4

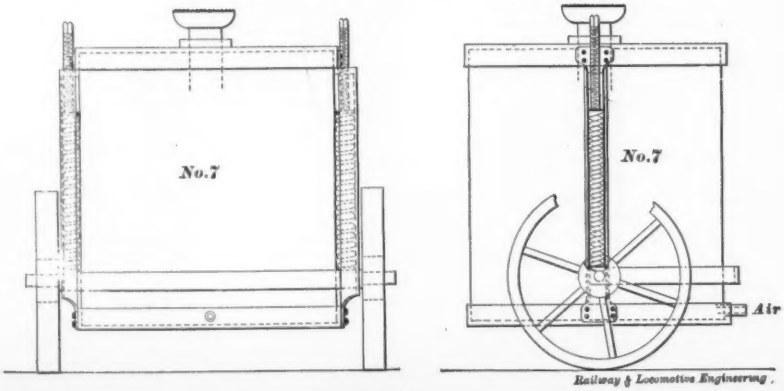


Railway & Locomotive Engineering

Fig. 5

AIR JACK DETAILS.





Railway & Locomotive Engineering.

AIR JACKS.

Recent Improvements in French Lighthouses.

The well-known completeness of the French lighthouse service, and the promptness with which improvements are adopted, renders the French coast the best protected in Europe, and for this reason the paper of Baron Quinette de Rochemont, read before the Waterways and Maritime Works section of the Glasgow Congress doubtless represents the latest modern practice.

"One of the chief improvements has been the adoption of *feux éclairs*, or lightning lights. With this new device the maximum efficiency of the illuminating apparatus is obtained; whether the illuminant be oil or electricity, it has given rise to quite a series of new types of appliances used in connection therewith. Again, the luminous efficiency of the optical apparatus has been increased by improving the focal precision, and by keeping the characteristic or effective divergence within narrow limits. The generating stations for electric lighthouses, built until quite recently on old-fashioned lines, have been brought up to date with all modern improvements. The adoption of incandescent burners for compressed gas or petroleum vapor has been a great step in advance. Not only has the intensity of the light been increased, but a light with a wick and ordinary mineral oil can now be made to burn continuously night and day for three months, with only occasional examination at long intervals of time. These permanent lights can have all the characteristics of superintended occulting or flashing lights. The adoption of permanent lights has enabled points of secondary importance to be lighted under economical conditions, and has thus efficiently filled a gap in the system of maritime illumination. Other permanent lights, in the form of illuminated buoys fed with oil-gas, have been adopted on an extensive scale, either to increase the protection at dangerous points and as substitutes for certain lightships, or for lighting, winding and shifting channels; also for supplementing the indications afforded by leading lights or sector lights, or for pointing out the position of works in construction at the entrance of harbors."

The lightning flash system is usually employed with electric arc lamps of high power, and is used especially for lighthouses of the first order, and it has been so fully described, that it need not be discussed at length here.

More recent is the application of incandescent mantles, heated by compressed gas or petroleum vapor.

"Incandescence with low-pressure gas only gives a comparatively feeble intrinsic brightness. Compressed gas must be used in order to obtain a greater intrinsic brightness than that afforded by the largest petroleum burners in use. With compressed gas, the quantity of gas supplied to the mantle, and the rate of combustion, vary in proportion to the pressure; whilst the dimensions of the incandescent light remain unaltered. The temperature of the mantle and its intrinsic brightness are therefore gradually increased. To overcome the objectionable condensation which occurs when coal gas is used, even at low pressures, the Pintsch gas, which is already in use for lighting buoys, has been adopted. This gas can bear a pressure of 10 or 12 kilogrammes (140 lb. to 168 lb.) without condensation, so that it can be stored in small portable reservoirs.

"The necessity of building works for supplying the oil gas has limited the application of incandescent gas lighting to a few important lights. The Lighthouse Department therefore has endeavored, with success, to obtain the same advantages, for a slight outlay, by substituting petroleum vapor for incandescent lighting. The burners employed are all made on the same principle, but their arrangements differ slightly according to the type of lighting apparatus for which they are intended. This principle consists in injecting the liquid petroleum into a vaporizer, heated by the mantle; the vapor then passes into the Bunsen burner of the mantle, after mixing with the air required for combustion. In starting, the vaporizer is heated by a spirit flame to the required temperature.

"Incandescent gas lighting, when no special gas works are required, is not much more expensive than lighting with a three-wick burner; and even when special works are necessary it is more economical than a five-wick burner. The annual expenditure for gas lighting does not exceed 1,800 francs (*72l.*) with gas

works, or 800 francs (32*l.*) without works; for petroleum vapor lighting it amounts to 650 francs (26*l.*). These figures show at a glance the advantage, from an economical point of view, of the system of incandescent lighting.—*Engineering Magazine.*

Compressed Air Ice Machine.

Among the earliest efforts in the way of building refrigerating machines, the air machine will be found to have a prominent place.

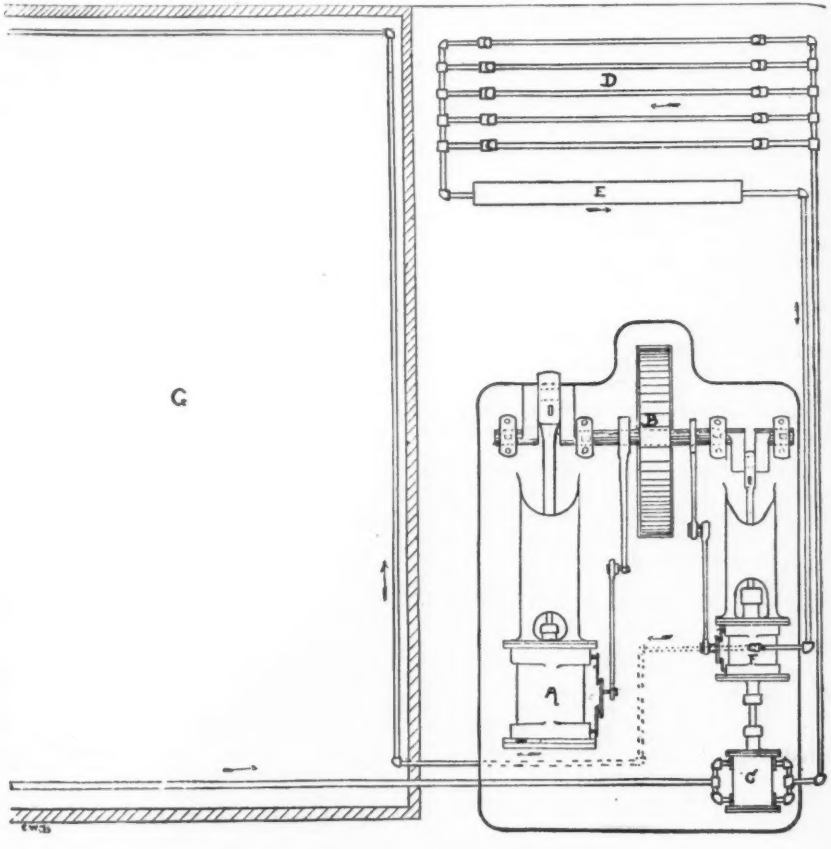
An explanation of the refrigerating effect of compressed air is as follows:

Air being an elastic fluid, it is subjected to a heavy pressure and compressed into cylinders, as shown in the accompanying sketch.

A—Steam Cylinder.
C—Air Compressor.
D—Cooling Coil.
E—Oiling Inceptor.
F—Expanding Cylinder.
G—Circulating Coil.

The air is taken into cylinder "C" or the compression cylinder from coil "G," which is used for the circulation of the cooled air.

By passing the air through the compressing cylinder, it is compressed into a



A COMPRESSED AIR ICE MACHINE.

density of ten or fifteen atmospheres. The heat held in specific form is intensified from 75 degrees in its original form to 300 or 400 degrees in a compressed condition.

This heat is conducted off by the compressed air being held in a coil surrounded by water, or in long pipes passing through the atmosphere, as when used for rock drilling appliances.

When the temperature of the compressed air has become reduced by conduction to its normal temperature of 75°, it is still compressed to 15 atmospheres.

Should this be allowed to escape into the atmosphere at this point, a temperature of from 10° above zero to zero would be obtained, part of this low temperature being due to the energy required to force itself into the atmosphere against atmospheric pressure of 14.7 lbs. per square inch.

Should the compressed air be allowed to expand into a chamber, in which there was a vacuum, the result would be a higher temperature.

We have still another action for the air, which is its passage through the expanding cylinder. This cylinder has a cut-off valve motion, and the air entering at, say, 150 lbs. pressure, aids the steam cylinder in its work.

Here is demonstrated the fundamental law, that all motion or power exerted is actuated solely by heat, for the air in expanding in the cylinder has consumed the heat until it is delivered into the cooling coils at from 40 to 70 degrees below zero.

An inquiring mind might ask, "What becomes of the heat as it passes through the expanding chamber?" and as we have as a result energy, as shown in the cylinders of a compressed air rock drill, and as it seems impossible to determine the dividing point between energy and heat, it may not be far out of the way to claim they are one and the same thing.

Just what connection this line of thought has with the bursting of strong into cylinders by the freezing of water, of which we are all familiar, we are not prepared to say.—*The National Engineer.*

An Economy.

A correspondent of *The Engineer* living in California recently described a novel method of economizing in fuel. The plant, which is installed at a mine, comprises two horizontal return-tubular boilers 54 inches in diameter by 16 feet long, one 12 in. x 12 in. double-cylinder hoisting engine, a 14 in. x 22 in. duplex air compressor, and a smaller steam engine for driving a rock breaker and ventilating fan. The fuel is crude oil, presumably the product of the Southern California wells. The hoisting and rock-breaker engines are steam driven, while a 150-horse power Westinghouse induction motor drives the compressor, which furnishes air at 80 pounds pressure for the rock drills. The air compressor was formerly considerably underloaded for the greater part of the time, being worked about 50 per cent. of its capacity.

It appears that the electric company will not furnish at this point less than 200 amperes, at a potential of 600 volts, at anything approaching a reasonable price, and, inasmuch as this amount of current must be paid for whether used or not, it was determined to put it to some use with the present apparatus. The motor and air compressor are now worked to their full capacity and the excess of air forced into the steam boiler. At times when the load on the hoisting and breaking engines is very light the compressed air becomes the only motive fluid, the consumption of oil under the boiler falling almost to zero, the boiler merely serving as a heater for the compressed air, while with the usual load the steam is employed to make up the deficiency. The saving in oil under the average full load is claimed to be 250 gallons in 24 hours, which amounts to about $10 per day.

The greatest difficulty experienced in thus utilizing the compressed air is said to be in securing proper lubrication of the engine cylinders. The steam is exceedingly dry, and when the load is reduced beyond a certain amount the quantity of steam furnished is insufficient to provide the required amount of condensation for the lubricators. It is stated in this connection, however, that it is thought that this difficulty can readily be overcome by employing force-feed lubricators, the use of which is anticipated should the existing conditions continue for any great length of time.

A Pneumatic Tube System of Parcel Distribution in Boston.*

BY EDWARD D. SABINE.

The 10-in. pneumatic tube system recently constructed by the American Pneumatic Service Co., in the city of Boston, marks a great advance in the application of compressed air to commercial purposes. The small pneumatic tube for cash and message delivery is well known both in this country and Europe, while the larger tubes for the handling of mail have been in successful operation in Philadelphia, New York and Boston for some years. The mail tube was discontinued in these cities last July on account of lack of funds, but its loss is being keenly felt, and restoration of the service will undoubtedly be authorized by the next Congress.

Although many schemes for utilizing the pneumatic tube for parcel delivery were proposed during the past decade, nothing was accomplished until in the fall of 1899 a group of Boston capitalists organized the American Pneumatic Service Co., and at once began the preliminary work. Active construction commenced in September, 1900, and the entire system was in operation by Aug. 1, 1901. The main station is situated at the corner of Essex street and Harrison avenue, in the heart of the retail shopping district of Boston. Bundles are collected from the stores and taken to the main station, which is directly connected by tube with the sub-station in the Back Bay, 1½ miles distant, and in the South End, about a mile away. From the South End a line runs to Roxbury, a distance of little more than a mile, and thence to Dorchester, a mile and a-quarter further. Each line consists of two lines of 10-in. cast-iron pipe laid side by side, one being used for outward, and the other for inward business. The pipe used in the straight runs is ordinary water-pipe coated as usual on the outside, but left clean inside. The joint used is the standard bell and spigot, except that the bell is counter-bored and the spigot turned to fit. In order to provide for slight variations in the diameter of the pipe, the inside is chamfered at the joints to 10⅛ ins. This joint allows a slight deflection from a straight line, which is very useful in changing grades and alignment in laying.

In laying the pipe great care was observed in addition to the usual precaution taken in laying water-pipe. Each joint before and after leading was tested with a mandrel, to make sure that no shoulder existed on which a carrier could catch. In wet ground the pipes were bedded in the best bank gravel obtainable. This care has been well repaid, for no trouble by settlement has occurred. The bends used were of iron elliptical in section, and 10¾-in. × 10-in., the long axis lying in the plane of the bend. The radius used for the bends is 128 ft. At either end of the bend is a tangent piece, 20 ins. long, in which the elliptical is reduced to a circular section.

The carrier is the greatest advance on previous practice of any of the novel elements of the system. It is cylindrical in form, 30 ins. long inside and 9 ins. in diameter. The door is on the side, embracing about one-third of the circumference, and is 26 ins. long. At either end of the carrier is a cast-steel head which carries lugs for the wheels; of the latter, there are five at each end equally spaced, but the wheels at the two ends do not run in the same line. The heads have flanges, 9¾ ins. in diameter, at right angles to the axis of the pipe. These flanges prevent any serious leakage of air past the carrier while running. The wheels are drop-forged from open hearth steel, with the treads case-hardened to a depth of 1-32-in. That their life is long is certain, much longer than that of any style of packing used on sliding carriers; but the actual distance that a set of wheels can run is as yet undetermined. On the experimental line runs of 6,000 to 8,000 miles were made, but this has already been exceeded by carriers in actual service. The elimination of packing results in an enormous saving in the construction of a pneumatic tube system, as the pipe does not have to be bored or reamed.

The sending machine, or transmitter, is a simple adaptation of the air lock. The valves are moved by air taken from the current in the line, acting on an ordinary piston. Touching a lever starts the valves in motion and the whole cycle is completed without further intervention of the attendant. On the transit pipes directly in front of the transmitter is

*Chief Engineer, American Pneumatic Service Co., 89 State St., Boston, Mass.

placed a diaphragm. This is connected to the transit pipe in two places, about 4 ft. apart, so that normally the diaphragm is balanced. When a carrier leaves the transmitter, the difference in pressure between front and rear causes the diaphragm to overbalance sufficiently to move an auxiliary valve, which controls the main cylinder and replaces the transmitter in position.

The receiving terminal is even less complex than the transmitter. The end of the tube is closed by a simple revolving valve, which is operated by a piston and compressed air taken from the tubes, the incoming air being diverted about 10 ft. back. When the carrier arrives, the air, compressing in front of it, brings it gradually to rest. The air from the cushion is used to operate an auxiliary valve which controls the main air supply to the cylinder. When the carrier is nearly at a standstill, this auxiliary valve permits the cylinder to open the revolving valve at the end of the pipe and the carrier rolls out. A diaphragm similar to the one on the transmitter closes the receiver, the whole operation being automatic and occupying about four seconds.

The compressed air used is furnished by belt-driven duplex compressors of the Rand Drill Co., with cylinders 24 x 12 ins., with a piston displacement at 130 revolutions of slightly over 1,600 cu. ft. The average pressure is only 2 lbs. per sq. in. The compressors are driven by 550-volt 3-phase alternating-current motors of the internal resistance type. The alternating-current motor was selected on account of the absence of a commutator and all that that implies. The constant speed of this type of motor was also an inducement.

At every station is a compressor for each outward line from that station. The air coming in is led to a large tank, open to the atmosphere and partially filled with calcium chloride. The intake pipe of the compressor is connected with this tank, so that the air drawn in for compression passes over the chloride, which thoroughly dries it. By using the return air a great saving in chemical is effected, as only the air that is used to operate the terminals has to be replaced.

Bundles are collected by team and taken to the main station, there sorted and packed into the carriers. On arrival at the sub-stations the carriers are unpacked and the bundles turned over to the drivers for delivery. As it takes but three minutes for a carrier to go to the Back Bay Station, a mile and a-half away, some idea may be had of the saving of time.—*Engineering News.*

Compressed Air—Its Use and Advantages.*

By George M. Andrews, Supt. of Bridges and Buildings, Baltimore & Ohio Ry.

The use of compressed air in large shops is too well known to need much comment; by its use mechanics have demonstrated its utility in both construction and repairs of various kinds of machinery, in the operation of the various cranes and hoisting appliances of the shops, in fact, its powers are almost unlimited. If this is so for shops, why not equally useful for field work?

Having seen its advantages in shop work, and knowing that it had been extensively used in erection, the writer having a large amount of bridge work to do (principally strengthening) asked for a plant sufficiently extensive to demonstrate its practical utility. The request was granted, and the result has proven the move a wise one. That others, with similar work, might profit by the experience gained, I will endeavor plainly and practically as possible to give a description of the necessary plant and tools for an outfit for general bridge and field work.

It will be noted that the plant I describe is one operated by steam, and some will no doubt ask, Why not use a gasoline plant? This, of course, is optional, but the writer prefers the steam, reasons for which it is not necessary to state in this paper.

The plant I have in operation consists of an air compressor, capacity 95 feet of free air per minute, a 25 horse power boiler, a water tank of 300 gallon capacity, and an air receiver of 150 pounds capacity. This plant is mounted on a car as shown on plan. When in use the car is placed on a side track as near as possible to the bridge on which the work is to be done; ¾ or 1 inch wrought pipes are then connected to the air receiver or reservoir, and run to the bridge. At intervals along the bridge, hose connections and globe valves are placed in line of pipe for

*A paper read before the Association of Railway Superintendents of Bridges and Buildings, Atlanta, Ga., Oct. 15-16, 1901.

connections to various tools. The tools ordinarily used consist of drills, riveting hammers and chipping hammers; forges can also be arranged to be operated by the air. In operating, care must be taken to occasionally blow out this pipe to prevent the accumulation of rust or dirt. Good wire-bound rubber hose should be connected to the pipe for tool use, as flexibility is required for moving tools from point to point.

In locating the plant for operation, it is necessary to consider the water supply, as considerable of this is needed, not only for the boiler, but for the cooling of cylinders of air compressor. This is just as important where gasoline or gas engines are used. For this purpose I have installed with the plant a small steam pump which can be set up at the nearest stream, spring, or well, and 1-inch pipe run to the car on which the compressor is installed, and by this means an ample water supply can be furnished at small cost. Steam for operating this pump is supplied from the boiler operating compressor.

Of the tools used, there are a number of various manufacture in the market, all of which possess more or less merit. The kind I have in use are as follows:

Little Giant Air Drill Press.

Boyer short stroke riveting hammer, No. 0.

Boyer long stroke riveting hammer, (the new long stroke).

Boyer chipping hammer, No. 1.

Boyer yoke hammer.

(For ordinary work would not recommend the purchase of the latter).

In the drill press, Morse twist drills are used, the shanks of the various sized drills being made to fit the press. For chipping hammers, cape chisels, etc., blanks are furnished by the manufacturers to be made up into the style necessary, or the same can be made in one's own shop. The style of tools necessary will be developed by the class of work to be done. As before stated, the plant should be placed as close to the work as possible. This is, however, only as a matter of economy in the running of pipe.

I have operated it as far as half a mile from the bridge on which work was done. A plant such as I have described, exclusive of the air pipe for conveying air from plant to bridge, will cost about $1,600 (sixteen hundred dollars).

The cost of operating a plant of this character depends in a great measure on the foreman in charge of the work. The man in charge of the plant should not only see to the proper firing of boiler and running of compressor, but should do the drilling, or assist in same, for all work such as plates, angles, etc., that can be done at car. By doing work of this kind, the actual expense of man for running plant will be reduced at least one-half. The amount of coal used will approximate about one-quarter ton per day. Ordinary repairs to compressor can be made by the gang in charge.

In the eighteen months that our machine has been in use the repairs have been very slight and machine is still in excellent condition.

For the drills and riveting hammers the expense is heavier, but as extra valves are supplied, and of which at least two should be carried in stock, there need be no delay in loss of tools while waiting for repairs, as the workmen soon become skilled in the handling of the tools, and can make all ordinary repairs, such as replacing valves, etc.

I have been asked by many where I found economy in a plant costing sixteen hundred dollars, and which could only be used by one gang at a time; this I answer by claiming the same superiority of this method over the old slow plodding use of hand drills, as the steam hammer is above the hand hammer and anvil, as the use of air in large shops is above the old method of hand work for every purpose, as the electric motor is above the horse car. I might continue on through all the improvements of the age were it necessary to clinch the argument, but as the work of a man or machine is their best argument, I only need point to that in this case.

In the use of air drill we find two men can, under ordinary conditions, drill from five to six holes to one by hand by the same number of men. The drills can be used under ordinary conditions wherever hand drills can be used.

In riveting, two men will, under ordinary conditions, do the work of three men with hand tools. As is well known by all bridgemen, we use, as a rule, three men besides the heater, for riveting, one to hold on, two to drive. With the pneumatic hammer, one to hold on and one to drive is all that is necessary. An additional advantage in this tool is that any intelligent helper can be taught the use of it by a

skilled foreman in a day, whereas, under the old hand method, skilled riveters must be employed. Of course, this method, like the hand driving, must be watched to avoid loose rivets. My experience in this has taught that up to 7/8 rivets, this method is not only effectual, but highly economical.

In the handling of this plant it must not be overlooked that after drilling and riveting on large jobs are completed, there is still another use for the compressor. It is a well known fact that in painting bridges, one, if not the most expensive, is the cleaning of the metal before applying paint. By having a sand blast machine, of which there are a number in the market, attached to outfit, bridges can be cleaned in not only less time, but much better. Personally, I have not used a machine of this kind, but have seen it used elsewhere, notably the 155th street viaduct, New York City. I am now in communication with a manufacturer of sand blast machines with a view of adopting it in manner described.

In conclusion, I have a few suggestions to offer:

1. That any one having a large amount of field work in which there is considerable field drilling and riveting to do, should beyond doubt install a plant of this kind.

2. That all who are inclined to doubt and who have sufficient work to justify it, should either try the method or see it in practical operation before condemning it.

3. That if the manufacturers would reduce their apparent exorbitant prices for drills, hammers and repair parts, many more would be in use.

4. That as this is an age of advancement and progressiveness, and one in which no man can remain inactive, and at same time keep abreast of his fellow-workers, it behooves all to watch carefully the improvements in their special line, and grasp all possible opportunities for the economical handling of their work, as well as relieving their employees of unnecessary laborious duties.

If this paper will in any measure assist in this line, the writer will be more than recompensed for his labors.—*Railway and Engineering Review.*

Compressed Air as a Safe Power.

Considerable attention has been called recently to compressed air explosions, so much in fact, that an impression might be given that compressed air is an unsafe power. On the contrary, it is the safest power or means of transmitting power that is in use at the present time. When we consider the great number and variety of uses to which compressed air has been applied in its comparatively short period of development, it is to be expected that some failures would occur, but it is only through ignorance of the cause of these explosions and carelessness on the part of engineers that these troubles do exist.

Compressed air installations are used with pressures up to 3,000 lbs. to the square inch, not only in every mine of any magnitude, in all tunnel work, quarries, ship-building, submarine work and for refrigerating purposes, but it has a very wide range of usefulness in all railroad and manufacturing lines. Nearly every railroad, machine, erecting, boiler shop and foundry of any size has its own compressor plant, and from all of these varied sources comparatively few accidents have been reported. As a means of safety many of the powder magazines throughout the country are using compressed air as a motive power, to the exclusion of steam and electricity. Railroad trains, both freight and passenger, are equipped with air compressors and storage tanks, and, on the latter the power is used for as many as eight different purposes, such as the braking of trains, ringing bells, opening fire doors, shaking grates, sanding the rails, lifting tender water scoops, raising water in passenger coaches and operating fans for ventilation.

The reason why compressed air is a safe power is the fact that it has no reserve force, as in the case of steam boiler explosions, where the destructive effect is caused chiefly from this force, that is, the sudden conversion of large volumes of superheated water into steam, by the reduction of pressure above the water space in the boiler. In the case of air, when a vent occurs, it serves to reduce the strains. This is due not only to the expansion of the air from a smaller space into a larger one, but a rapid reduction in volume, due to the fall of temperature in expanding. The failures that have occurred in the use of compressed air can, in nearly every in-

stance, be traced back to the ignition of oil or some inflammable substance which is used with the air. Low-test lubricating oil, for example, fed to the air cylinders, may meet with a temperature greater than that of its flashing point. In putting oil into the cylinders, any surplus that may reach the cylinders is forced out through the delivery valves into the air pipes and receivers. The products of decomposition of a large quantity of oil in the receiver would, with the air, form an explosive mixture.

Air in itself is a perfectly safe fluid, and only requires a vessel strong enough to hold it. In this respect, the problem is not a serious one, as the factor of safety in the case of air may be less than for steam, water or gas, as it does not corrode the vessel, its temperature is not changed, and it causes no internal destruction.

It will thus be seen that air is the cleanest, healthiest and, except through the course of compression, is as nearly absolutely safe as any power of this kind can be.

Notes.

In an air compressor at 100 pounds gauge pressure 1 cubic foot corresponds to 7.82 cubic feet free air; at 80 pounds pressure, to 6.46 cubic feet; at 60 pounds, 5.10.

Traction by compressed air is being installed at the Massachusetts Cotton Mills, at Lowell, Mass., as the result of the factory mutual insurance companies objecting to traction machines operated by steam or electricity on account of the fire hazard involved. About 3½ miles of trackage outside are to be thus operated, as well as about 2 miles under cover.

Compressed air wasted from power drills is so contaminated with oil from the cylinder that it cannot be taken into consideration as ventilation. It is as important to displace it with pure air as it is to drive out or draw off other vitiated air. The ventilation should be an independent supply provided by fan or blower, delivering by pipe at the point where miners are working.

The general offices of the Standard Pneumatic Tool Company, formerly in the Marquette Building, Chicago, have been removed to the new works recently completed at Aurora, Ill. The company report their business for the month of October to be the largest since their organization, and they have recently equipped several complete air plants with Little Giant pneumatic tools and compressors.

The Pneumatic Engineering Co., 128 Broadway, New York City, has recently published a circular entitled "Just Turn On The Air," in which is illustrated and described the Halsey Pneumatic Pump. This pump, it will be recalled, has been developed to raise water from mines or wells, without the use of any moving parts other than valves which are on the machine. It uses compressed air and is a very satisfactory substitute for steam and other pumps. Copies of the circular can be obtained by writing to the Pneumatic Engineering Co.

Hot compressed air is said to have been used with success to start a petroleum well flowing, after steam and compressed air at atmosphere temperature had failed. The failure of the latter was probably due to its cooling under expansion after leaving the air pipe, thus tending to freeze the petroleum in immediate contact with it. The hot compressed air expanding did not cool down to a temperature which would tend to solidify the petroleum, but, possessing an excess over atmosphere temperature after expanding it softened the petroleum so that it would flow.

One of the most interesting of the outdoor exhibits of the Glasgow International Exposition at Glasgow, Scotland, was composed of two Ingersoll-Sergeant rock drills mounted and ready for operation. One of these drills was the well-known "Baby" type of auxiliary valve drill, while the larger drills were represented by a "C" drill of the same type. These were mounted on large blocks of stone and were started or stopped at the request of visitors or they could be run by the visitors themselves. Exhibited this way they afforded a much better idea of what a rock drill is than if standing idle, and when in operation they attracted a great deal of attention.

The Garry Iron & Steel Co. is exceptionally busy on its new type of pneumatic crane and regular structural business. Among other recent contracts is one for all the structural steel in an immense industrial plant at Pueblo, Colo. This will doubtless be the only all steel wagon factory in the country. The enterprise is already incorporated with a capital of $350,000 as the Steel Wheel & Wagon Co. Wm. H. Schofield is president and general manager; George W. Bowen is vice-president; H. T. Wright, treasurer, and S. I. Heyn, secretary. These gentlemen and R. H. Lee, superintendent of the Minnequa plant, are the directors of the company. Every part of the Schofield wagon is made of steel, with the exception of the tongue.

An important duration test of the submersion of a submarine torpedo boat was carried out with the Holland submarine boat Fulton in Peconic Bay, off Cutchogue, L. I., on the night of Nov. 23. The vessel was submerged for a period of 15 hours, lying upon the bottom of the harbor with a crew of eight men, including naval officers and officials of the Holland Co. The vessel was submerged in 15 feet of water, with the top 6 ft. under water. There was no connection whatever between the boat and the shore. During the time the vessel was submerged there was a heavy storm, doing considerable damage on shore, but conditions on the surface were unknown to the occupants of the submerged vessel, the boat not being disturbed in any way. The vessel was equipped with tanks of compressed air to replenish the air in the vessel for breathing purposes, but none of it was used. The vessel rose by forcing the water ballast from its compartment by releasing one of the flasks of compressed air.

The unusually dry seasons which Southern California recently had, caused a greater demand for improved pumping machinery and a typical plant was lately installed at Pomona. There are two boilers of 100 h. p. each, driving air compressors so located that steam connections may readily be broken and electric or other power substituted. There are 16 wells that deliver a total of $3,250,000 gallons in 24 hours, and the water is raised from the wells by air-lift. The air pressure carried is from 45 to 55 pounds per square inch, and a pressure governor gives relief in case of clogging of the pipes and undue rise of pressure. The air is led from the compressors to the wells in sheet steel pipe, of which there is more than a mile and a half, gradually reduced in diameter according to the number of wells served from the main line. The exhaust from the compressors is condensed into a hot well and fed to the boilers through a reheater in the stack. The boilers are fired with oil through a Hamill burner and there is a cement oil tank holding 299 bbls. of fuel oil, from which the fuel supply is drawn.

On October the 16th, the International Correspondence Schools celebrated its tenth anniversary. Ten years ago Mr. Thomas Coates, of Peckville, Pa., enrolled as the first student of the schools and his enrollment marks the beginning of one of the most successful careers that has ever attended the launching of any enterprise in any city in the United States. The growth of this institution from October 16, 1891, to the present day, has been wonderful. In 1891, eight or nine persons performed the work that now necessitates the services of an army of 2,500, and up to the present time 341,500 students have enrolled in the schools.

Some months ago, the Franklin Institute, the oldest, most conservative and most influential scientific body in America, on behalf of the Philadelphia export exposition, awarded the International Correspondence School the highest award, a diploma and silver medal, for "a unique, thorough and comprehensive system of technical education by correspondence." It would be hard to find words more befittingly descriptive of the International Correspondence Schools system than those used by the Franklin Institute.

The location of the schools has been a great boon to the city of Scranton. They give employment to an army of people and they enjoy the reputation of having the best-paid force of any institution in the city. Altogether, the International Correspondence Schools is an institution of which the city of Scranton may be justly proud, and in the succeeding ten years we wish it even a greater success than it has enjoyed during the past decade.

The economy of the paint spraying machine over the hand brush for certain kinds of painting has been well demonstrated by the large number of these machines which have of late years been introduced into railway work. In the usual arrangement there is a pot with a spray nozzle operated by compressed air through connection with some compressor plant. To make use of a paint spraying device independent of any compressor plant, is the idea of a hand operated machine recently put forth by J. A. & W. Bird Co., 35 India street, Boston, Mass. It is a portable device, and so cheap and so simple in operation that the modern method of painting by the spray action is readily put within reach of all interested parties.

Briefly described, the device consists of an open tank of convenient capacity and a hand force pump. This force pump has double pistons and forces the paint against air pressure in the head or upright reservoir. The pressure thus set up forces the paint out through a hose of desired length with a spraying nozzle at the end.

The machine, known as the "Magnite Spray Pump," is mounted on ball-bearing casters, and can be readily moved from one place to another. The paint is at all time accessible, and, if so desired, it can be constantly agitated. The tank is made of sheet iron and can be kept clean.

The pressure maintained is 100 lbs. per sq. in., being easily kept up by one man. Two nozzles can be used to good advantage without lowering the pressure of 100 lbs. It is easily cleaned by simply pumping clean water, benzine or naphtha through the pump after using, and does not have to be taken apart to be cleaned.

The machine can be used for applying oil paint, water paint, kalsomines and washes, for applying antiseptics on the walls of hospitals and other buildings, and for spraying oil, water, etc., on floors to lay dust. The work is also rapidly done, it being claimed that two men with a Magnite painting machine can do the work of 16 men at hand painting.

The manipulation of the machine and the work of painting is a simple matter. First the paint is mixed and strained carefully to remove all lumps or particles. When the paint is properly mixed, the tank is filled and the valve on the outside of the tank and pump is opened and the pressure worked up to 100 lbs., as indicated by the gauge on top of the reservoir. Pressure should be kept at not less than 100 lbs. to get the best results, as the paint spray is broken up into smaller particles at this pressure.

The machine is in service on the Southern Pacific, Boston & Maine, Lehigh Valley, Seaboard Air Line, Maine Central, and some other roads.—*Railway and Engineering Review.*

A tunnel for a tramway under the River Spree, at Berlin, is driven through mud and sand heavily charged with water. The total length is 2,017.2 feet, of which 1,490.3 feet are tunnel proper; the grade of the tunnel lies 39.36 feet below the main level of the river, and the least thickness of soil between the top of the tunnel and the bottom of the Spree is about 10 feet.

The tunnel is formed of a cast steel cylindrical shell 4 m., or 13.12 feet, in diameter, made in rings and covered with cement mortar both inside and outside. The exterior layer of mortar is 3⅛ inches thick, and the inside layer 4¾ inches thick. At the bottom of the tunnel is a concrete floor, carrying the rails, and also a drain for taking away any water that may filter into the tunnel. The cylinder rings are 2.13 and 1.64 feet wide; and they are each made of nine plates fitted on all four sides of each plate with inside flanges for bolting together. Between these rings, during erection, flat steel circles are bolted, projecting outward and thus increasing the rigidity of the metallic tube.

The actual excavation is done with an advancing shield and under compressed air. The shield is made of a double, transverse bulkhead, enveloped in a cylindrical hood; the front of this hood being cut away on an angle of 45° to protect the men at work. As shown in the illustration, this hood is closed on the oblique front by a metal covering, provided with hinged doors, which may be opened at will. The material removed through these doors is thrown into the bottom part of the hood, and is then removed by a sand pump, with its pipes passing through the transverse bulkhead at the bottom. This advance hood is closed in the upper part, so that a space filled with air is left as a refuge for the workmen in the case of a sudden inflow of sand and water. For the same purpose the air lock is placed in the bulk-

head which separates the working chamber from the space to the rear of the shield in which the rings are being built up.

The actual construction chamber, in the rear of the shield, is included between the front transverse bulkheads, and a temporary transverse wall of masonry situated some distance in the rear of the shield, and fitted with two air locks—one for men and the other for materials. The steel rings are mounted under the rear of the shield, and the outside cement is rammed in place, the diameter of the cylindrical shield hood being large enough to admit this cement over the rings. This outer coating of cement also seals the working chamber against the sand and water outside. The shield is pushed forward by sixteen hydraulic rams, abutting against the last steel ring put into place, in the usual manner.

This tunnel was commenced in February, 1896, and was finished in February, 1899; but, after finishing 525 feet of the tunnel, the work was interrupted for one year. It was finished without any serious accident, and a tunnel of similar design and 6,560 feet long is now under construction at Hamburg.—*Engineering News.*

U. S. PATENTS GRANTED OCT. 1901

Specially prepared for COMPRESSED AIR.

683,431. AIR-GUN. Frederick F. Bennett and William J. Burrow, Plymouth, Mich., assignors to the Daisy Manufacturing Company, same place. Filed Jan. 23, 1901, Serial No. 44,415.

683,533. ROCK-DRILL. Wirt W. Waite, Colfax, Wash. Filed Jan. 22, 1901. Serial No. 44,307.

683,614. AIR-COMPRESSOR. Charles R. Meston, St. Louis, Mo., assignor of one-half to the Emerson Electric Manufacturing Company, same place. Filed Jan. 23, 1901. Serial No. 44,444.

683,628. COAL OR ROCK DRILL. Isaac Wantling, Peoria, Ill. Filed June 8, 1901. Serial No. 63,717.

683,659. APPARATUS FOR HEATING AND AGITATING AIR. Edwin F. Porter, Boston, Mass., assignor to the Bay State Electric Heat and Lighting Company, Jersey City, N. J. Filed Feb. 17, 1898. Serial No. 670,616.

683,666. PNEUMATIC-CONVEYOR VALVE. Grant S. Shannon, Houston, Tex. Filed April 29, 1901. Serial No. 57,955.

683,740. PNEUMATIC WHEEL-TIRE. Albert M. Ferguson, Winnipeg, Canada, assignor of two-thirds to Thomas Carroll Allum and Henry Duncan Metcalfe, Montreal, Canada. Filed March 29, 1901. Serial No. 53,537.

683,864. MINING-MACHINE. Henry C. Sergeant, Westfield, N. J., assignor to the Ingersoll-Sergeant Drill Company, New York, N. Y. Filed Jan. 29, 1901. Serial No. 45,202.

683,911. DRIVING CONNECTION FOR COMPRESSORS. Oliver H. Castle, Indianapolis, Ind. Filed Jan. 2, 1901. Serial No. 41,821.

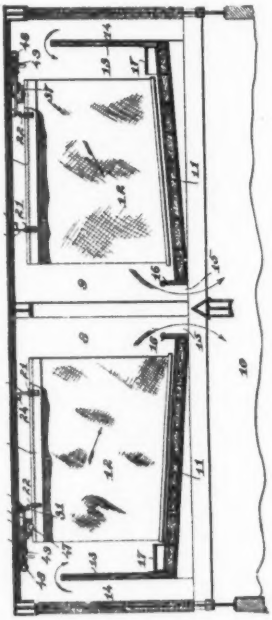
683,935. AIR-CURRENT MOTOR. John A. Hensel, Chicago, Ill. Filed May 12, 1900. Serial No. 16,536.

683,997. PNEUMATIC STACKER. James B. Schuman, Columbia City, Ind., assignor of three-fourths to Augustin Boice, Indianapolis, Ind. Filed Dec. 19, 1900. Serial No. 40,354.

684,108. PROCESS OF LINING PNEUMATIC TIRES. Joseph Savoie, Central Falls, R. I. Filed May 29, 1901. Serial No. 62,447.

684,217. AIR-COOLING APPARATUS. Horace C. Gardner and Frank J. Gardner, Chicago, Ill., assignors to said Horace C. Gardner and Gustavus F. Swift, same place. Filed July 30, 1900. Serial No. 25,297.

An air-cooling apparatus, the combination of a trough, means for supplying a cooling liquid thereto, one of the upper side edges of said trough being serrated to provide for the



discharge of the liquid therefrom, a sheet suspended from said trough in contact with the serrated portion thereof so as to receive the discharge liquid as it escapes from the trough, the upper edge of said sheet being folded over the serrated edge of the trough from which it is suspended, and a rod in the folded-over edge of said sheet.

684,307. ENGINE FOR ROCK-DRILLS. Patrick H. Reardon, San Francisco, Cal. Filed March 29, 1900. Serial No. 10,684.

684,353. MINING MACHINE. Henry B. Dierdorff, Columbus, Ohio, assignor to the Lechner Manufacturing Company, same place. Filed April 2, 1886. Serial No. 197,558.

684,354. MINING MACHINE. Henry B. Dierdorff, Columbus, Ohio, assignor to Joseph A. Jeffrey, same place. Filed June 27, 1891. Serial No. 397,712.

684,355. MINING MACHINE. Henry B. Dierdorff, Columbus, Ohio, assignor to Joseph A. Jeffrey, same place. Original application filed June 27, 1891. Serial No. 397,712. Divided and this application filed Nov. 20, 1895. Serial No. 569,484.

684,356. MINING MACHINE. Henry B. Dierdorff, Columbus, Ohio, assignor to Joseph A. Jeffrey, same place. Filed Feb. 26, 1894. Serial No. 501,584.

684,357. MINING MACHINE. Henry B. Dierdorff, Columbus, Ohio, assignor to Joseph A. Jeffrey, same place. Filed July 31, 1895. Serial No. 557,740.

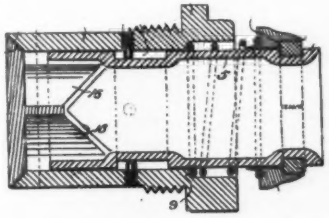
684,358. MINING MACHINE. Henry B. Dierdorff, Columbus, Ohio, assignor to Joseph A. Jeffrey, same place. Filed Aug. 9, 1895. Serial No. 558,765.

684,458. APPARATUS FOR HEATING AND AGITATING AIR. Edwin F. Porter, Boston, Mass., assignor to the Bay State Electric Heat and Light Company, Jersey City, N. J. Filed Dec. 6, 1897. Serial No. 660,957.

684,495. AIR BRAKE HOSE SPLICER. Delbert C. Carr, Rochester, N. Y. Filed March 22, 1900. Renewed Sept. 10, 1901. Serial No. 74,919.

684,550. PNEUMATIC TIRE FOR VEHICLES. Charles A. Pettie, Brooklyn, N. Y. Filed Dec. 20, 1900. Serial No. 40,541.

684,565. AIR COMPRESSOR VALVE. William H. Caster, Angels Camp, Cal., assignor of one-half to H. F. Whirlow, San Francisco, Cal. Filed April 2, 1901. Serial No. 54,005.



The combination in an air or like valve of a cylindrical casing, means for fixing it in place, said casing having a valve-seat formed

at one end, a counterbored chamber at the opposite end, a valve consisting of a head fitting the seat of the casing, a body slidably guided within the casing extending beyond the opposite end, and having an annular groove made around the projecting end, a ring formed in sections fitting said groove and projecting outwardly therefrom, a collar removably fitting the end of the valve having the outer end counterbored to inclose the sectional ring when the latter is in place, and a spring seated in the counterbore of the casing and pressing the collar against the ring, and acting to normally close the valve-head against its seat.

684,582. PROTECTOR CLAMP FOR AIR HOSE. John F. McGuire, Akron, Ohio, assignor of two-thirds to Thomas H. Barrett and Joseph Seabold, same place. Filed March 15, 1901. Serial No. 51,331.

684,647. MEANS FOR PLUGGING PNEUMATIC TIRES. Hans P. Madsen, New York, N. Y. Filed July 17, 1901. Serial No. 68,570.

684,678. PNEUMATIC DESPATCH TUBE APPARATUS. James T. Cowley, Boston, Mass., assignor to Lamson Consolidated Store Service Company, Newark, N. J., a Corporation of New Jersey. Filed July 10, 1901. Serial No. 67,753.

684,715. COMPOUND PNEUMATIC DESPATCH TUBE TERMINAL. Otto S. Pike, Malden, Mass., assignor to American Pneumatic Service Company, Dover, Del., a Corporation of Delaware. Filed Feb. 4, 1901. Serial No. 45,866.

684,735. AIR-BRAKE SYSTEM. Paul Whiting, East Las Vegas, N. Mex. Filed Aug. 28, 1900. Serial No. 28,311.

684,954. AIR COMPRESSOR. Herman Strater, Boston, Mass. Filed Mar. 16, 1901. Serial No. 51,563.

684,955. AIR COMPRESSOR. Herman Strater, Boston, Mass. Filed July 20, 1901. Serial No. 69,049.

685,002. PNEUMATIC TIRE FOR VEHICLES. Isaac S. McGlehan, New York, N. Y. Filed April 13, 1901. Serial No. 55,601.

685,027. GAS AND AIR MIXING APPARATUS. Ernest Blasser, Boston, Mass. Filed Dec. 17, 1900. Serial No. 40,076.

685,028. APPARATUS FOR SUBMARINE OPERATIONS. Chas. H. Brown, Port Huron, Mich., assignor of one-half to Stephen G. Martin and Abraham S. Martin, Port Huron, Mich. Filed Dec. 3, 1900. Serial No. 38,493.

685,117. COMPOUND AIR INSPIRATOR. Salyer R. Earle, Toronto, Canada. Filed Nov. 5, 1900. Serial No. 35,564.

685,169. AIR VALVE FOR WATER COCKS. William Paul, Savannah, Ga. Filed Jan. 29, 1901. Serial No. 45,199.

685,182. AIR BRAKE VALVE MECHANISM. Edward G. Shortt, Carthage, N. Y., assignor to the International Air Brake Company, Jersey City, N. J., a Corporation of New Jersey. Filed Sept. 13, 1899. Serial No. 730,298.

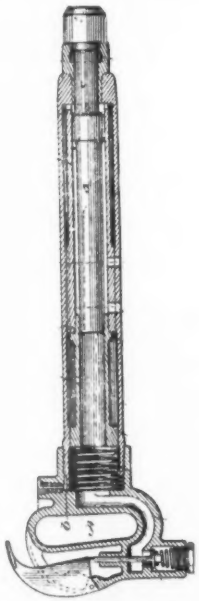
685,202. PNEUMATIC TUBE SYSTEM. John H. Dale, Newark, N. J. Filed Dec. 27, 1900. Serial No. 41,278.

685,270. PNEUMATIC TRACKER FOR MUSICAL INSTRUMENTS and AUTOMATIC MUSIC SHEET THEREFOR. Robert A. Gally, Brooklyn, N. Y. Filed April 25, 1901. Serial No. 57,373.

685,304. GAGE ATTACHMENT FOR COMPRESSED AIR FIRE EXTINGUISHERS. Russell B. Sigafoos, Racine, Wis. Filed July 17, 1900. Serial No. 23,920.

685,359. PNEUMATIC HAMMER AND RIVETER. Henry H. Vaughan, Chicago, Ill. Filed Feb. 1, 1901. Serial No. 45,608.

A motive fluid hammer or riveter, having a differential piston and provision for maintaining constant pressure on the head of the piston having the lesser area, the combination with said piston of a cylinder having within its walls a clearance space which com-



municates with that end of the cylinder which contains the greater head of the piston said clearance space between the cut-off point on the piston and the ports which open into the lower end of the cylinder having a clearance volume equal to at least twenty-five per cent. of the displacement of the greater head of the piston during one stroke.

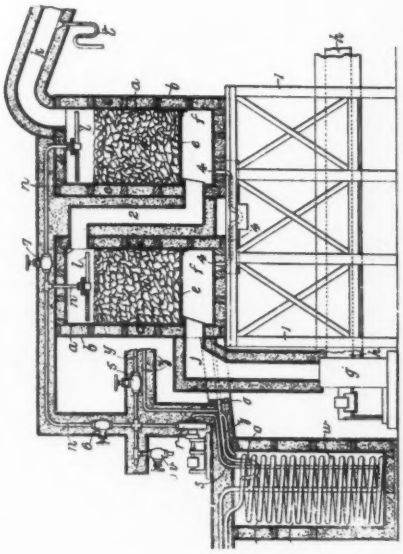
685,367. COMBINATION AIR AND GAS ENGINE. Charles A. Anderson, Erick A. Erickson, and John Wickstrom, Chicago, Ill., assignors to the Chicago Motocycle Company, Chicago, Ill., a Corporation of Illinois. Filed March 27, 1899. Renewed Feb. 20, 1901. Serial No. 48,172.

685,414. GAS AND AIR MIXER. Frank L. Stone and William A. Stevens, Franklinville, N. Y. Filed June 18, 1900. Serial No. 20,653.

685,478. AIR BRAKE COUPLING. John E. Jaco, Rowland, Tenn. Filed May 16, 1900. Serial No. 16,905.

685,510. AIR AND GAS MIXING AND GOVERNING DEVICE FOR GAS ENGINES. William P. Flint, Pittsburg, Pa., assignor to the Westinghouse Machine Company, a Corporation of Pennsylvania. Filed Sept. 6, 1900. Serial No. 29,203.

685,584. APPARATUS FOR COOLING AIR. Thomas Douglas, London, England, Filed Jan. 21, 1901. Serial No. 44,089.



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ing liquid on top of the pieces of material in each tower, a receptacle communicating with the air-distributing chamber of the first tower for collecting the cooling liquid, a pump for circulating the cooling liquid and an evaporator coil in said receptacle.

685,628. PNEUMATIC STACKER. George W. Morris, Racine, Wis., assignor to F. Lee Norton, Racine, Wis. Filed May 6, 1901. Serial No. 59,022.

685,674. TRANSMITTER FOR USE IN PNEUMATIC DESPATCH TUBE APPARATUS. James T. Cowley, Lowell, Mass., assignor to the American Pneumatic Service Company, Dover, Del., a Corporation of Delaware. Filed Feb. 26, 1900. Renewed Oct. 2, 1901. Serial No. 77,341.

685,704. DEVICE FOR CONTROLLING THE USE OF COMPRESSED AIR. Melville C. Wilkinson, Los Angeles, Cal. Filed July 15, 1899. Serial No. 724,000.

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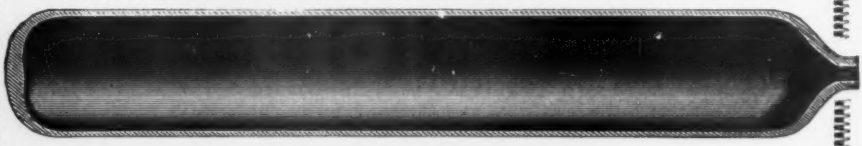

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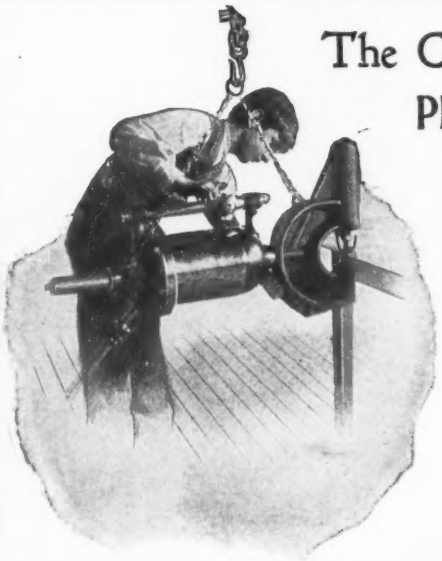

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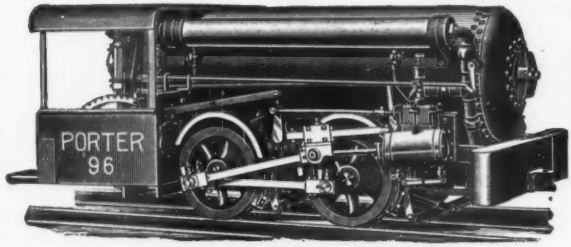

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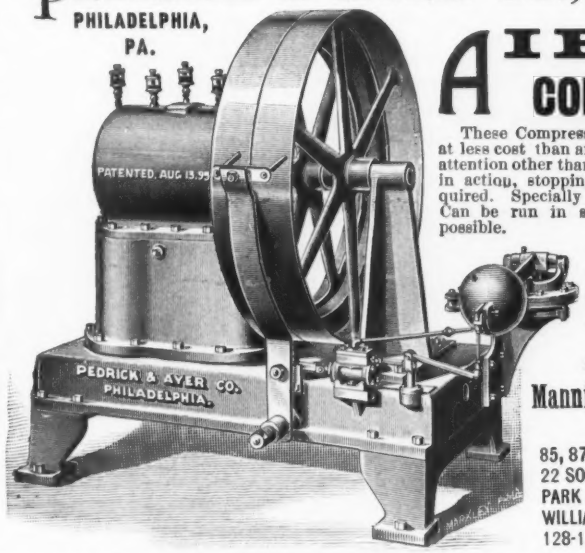

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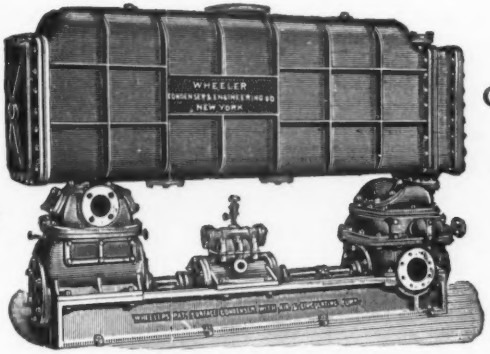

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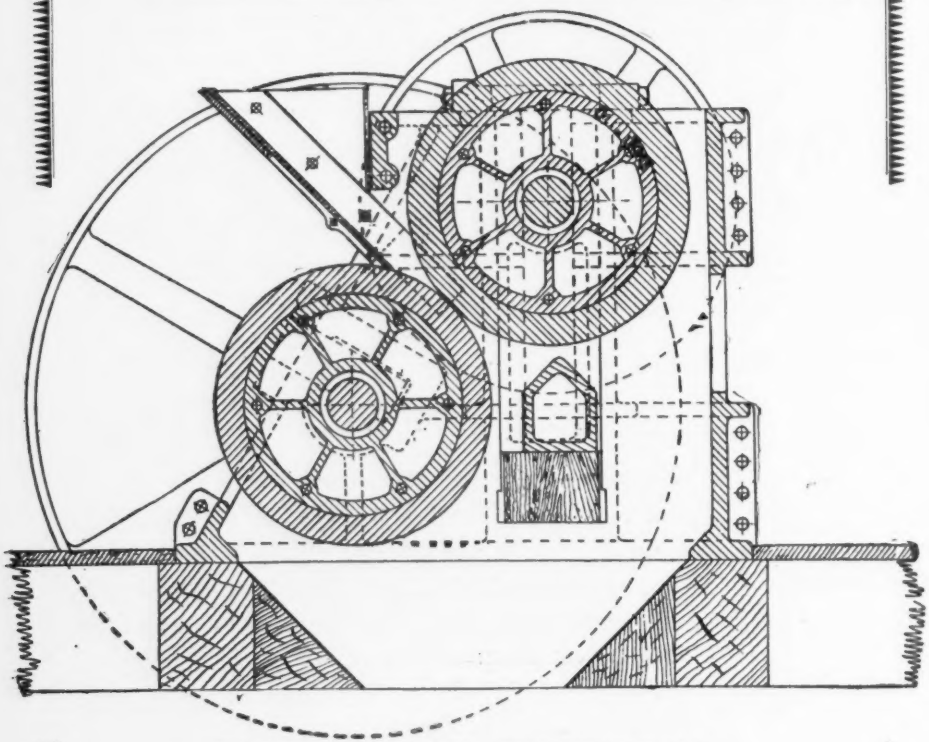

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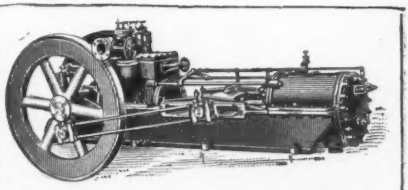

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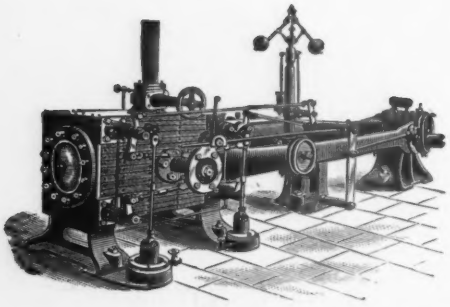

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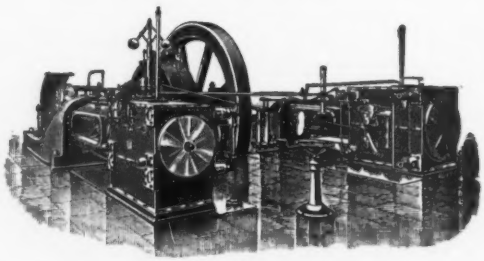

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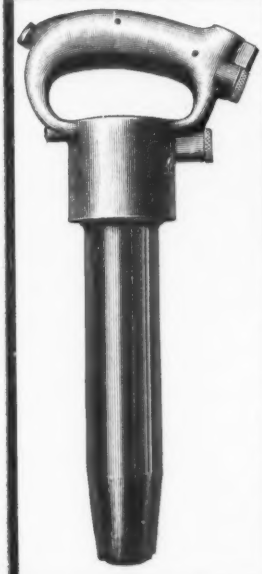

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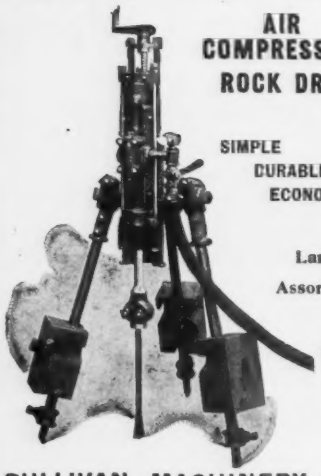

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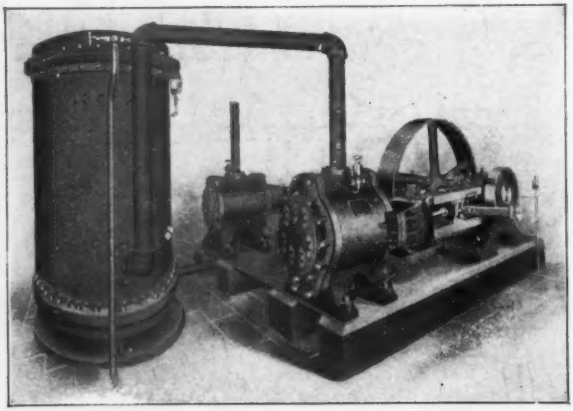

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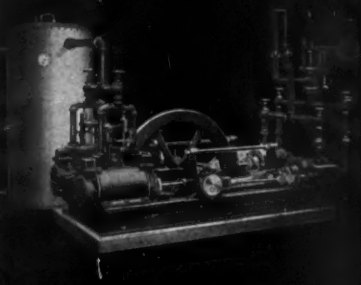

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